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T H R E E
T R E A T I S E S.

ON
THE BRAIN, THE EYE,
AND
THE EAR.

ILLUSTRATED BY TABLES.

BY
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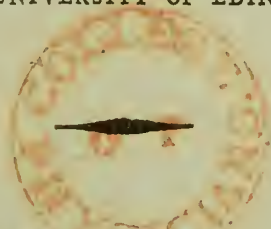
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OBSERVATIONS
ON THE
COMMUNICATION
OF THE
VENTRICLES OF THE BRAIN
WITH EACH OTHER;
AND ON THE
INTERNAL
HYDROCEPHALUS.

BY

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GENERAL

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TREATISE

TREATISE FIRST:
OF THE BRAIN.

CHAP. I.

Of the Communication of the Ventricles of
the Brain with each other, in Man and
Quadrupeds.

SO far back as the year 1753, soon after I began the study of Anatomy, I discovered, that the Lateral Ventricles of the Human Brain communicated with each other, and, at the same place, with the Middle or Third Ventricle of the Brain: And, as a passage from the Third Ventricle to the Fourth is universally known, it followed, that what are called the Four Ventricles of the Brain, are in reality different parts of one cavity.

B

In

In confirmation of this, I afterwards observed, in the bodies of fifteen different persons who had died of Internal Hydrocephalus, that the water was lodged in all the Ventricles; that by one puncture it was discharged from all of them; and that the passages by which I had found the Ventricles communicated, were dilated in the same proportion as the other parts of the Ventricles.

If, therefore, there has been no mistake in the observations of those who tell us, that in Hydrocephalus they have found the water confined to One of the Lateral Ventricles, or discharged by a puncture from One Ventricle, without emptying the others; there must have been, previous to the Dropsy, some degree of inflammation, or other disease, in that part of the brain, which had occasioned an obliteration of their natural communications.

I found likewise, that there is no passage, such as Dr HALLER, and other authors, supposed, (See HALLER, *El. Phys.* L. x. S. 2. § 6. p. 77. and S. 3. § 7. p. 87.) leading from the Cavity of the Fourth Ventricle into the Cavity, as it is called, of the Spinal Marrow, or, between the Dura and Pia Mater of the Spinal Marrow.

In

In the year 1764, I read a paper on that subject to the Philosophical Society of Edinburgh: And, in 1783, when I published my book upon the Nervous System, I gave such a full description of the Communications of the Ventricles of the Brain, illustrated by figures, that I did not suppose any person, who pretended to anatomical knowledge, could find difficulty in tracing by dissection all I had described.

To my very great surprise, however, I have been informed, that several Teachers of Anatomy in London have told their Pupils, that they had looked for such passages in vain; and therefore ventured to deny their existence.

But I cannot admit their inference: because, in the first place, I have found, on repeating my dissections in private, that the descriptions I published in 1783 are so correct, that I observe nothing material to add to, or to alter in them.

In the next place, since I heard of those doubts as to the facts I had described, I have demonstrated, annually, to all the Students of Anatomy who have done me the honour of attending my Lectures, every thing I had mentioned. Particularly, last winter, after I had demonstrated these parts in one subject, I dissected another, of which my assistant Mr

FYFE made a very accurate drawing; which I shewed to all the Students, who compared it with the subject.

But, that no doubt might remain with the most sceptical person, I have, this summer, repeated the dissection of a recent subject; of which, likewise, Mr FYFE made a very accurate drawing, that corresponds exactly with his former figure.

I then asked the favour of all my Colleagues of the Medical Faculty, to wit, Dr BLACK, Dr HOME, Dr RUTHERFORD, Dr GREGORY, and Dr DUNCAN, to compare the Drawings with the parts dissected; which they were so obliging as to do: And I subjoin their Declaration.

After they had finished their comparison of the Drawing marked Table First, with the dissected Brain; I held the end of a blow-pipe at the distance of half an inch from the hole by which the Lateral Ventricles communicate; and, on my blowing moderately, I shewed them, that the air passed from the Right into the Left Lateral Ventricle.

I then opened the Left Lateral Ventricle, and pointed out to them the hole by which the air had passed.

I afterwards made a Cast in Paris Plaster of the Parts represented in the First Figure: And this cast, which I preserve, corresponds exactly with the Drawing and Engraving.

DECLARATION by the PROFESSORS of the FACULTY of PHYSIC in the University of Edinburgh.

“ WE whose names are subscribed hereby declare, That on
“ the 13th day of June 1794, Dr MONRO demonstrated to
“ us, in the Anatomical Theatre, the Human Brain cut per-
“ pendicularly at the right side of its Septum Lucidum; and,
“ along with it, a Drawing of it, marked Table First, just
“ finished by Mr FYFE: That we examined and compared
“ these accurately together, and found them to correspond
“ in all respects; particularly, we saw distinctly a hole or
“ passage by which the Lateral Ventricles communicate with
“ each other, and with the Third Ventricle.

“ After this, Dr MONRO placed the small end of a common blow-pipe about half an inch from this hole or passage ; and, on his blowing air gently, we saw it pass through the above-mentioned hole or passage into the Left Lateral Ventricle.

“ He afterwards shewed us the Left Lateral Ventricle laid open, and a Drawing of its parts by Mr FYFE, marked Table Second ; and particularly, we saw the left side of the passage which makes the communication between the Ventricles.

“ He has, since that time, shewed us a Cast in Paris Plaster of the Parts represented in Table First, which we find to correspond exactly with the Drawing and Engraving.

“ We therefore entertain no doubt of the existence of the Communication of the Lateral Ventricles of the Brain with each other, and with the Third Ventricle, described by Dr MONRO in the Work he published on the Nervous System in 1783 ; and particularly, we attest the accuracy of the Figures and Description of these Parts which he
“ shewed

“ shewed us, and which he proposes to present to the Royal
“ Society of Edinburgh for publication.

“ JOSEPH BLACK.

“ FRANCIS HOME.

“ JAMES GREGORY.

“ D. RUTHERFORD.

“ ANDREW DUNCAN.”

MY very ingenious and intelligent Colleague Dr RUTHERFORD, who, as one of the ordinary Physicians of the Royal Infirmary, as well as one of the Clinical Lecturers there, has had frequent opportunity of examining this subject, has very obligingly favoured me with his farther attestation concerning it in the following Letter.

“ For

“ For Dr MONRO.

“ Dear Sir,

“ I am very much pleased with your Drawings and Description of the Communication of the Lateral Ventricles with each other, and with the other Ventricles of the Brain. The First Figure is particularly excellent ; and must certainly, I should think, remove all doubts respecting the reality of these passages. It seems indeed very strange, that so many celebrated Anatomists should have missed the Communication betwixt the Lateral Ventricles ; as it is so easily discovered, and as it is generally so very conspicuous when the Ventricles are distended by water preternaturally accumulated in them. Frequently, when examining the state of the Brain in persons who had died in the Royal Infirmary, I have taken the opportunity of pointing out this Communication to the Young Gentlemen who were present at the dissection ; and have satisfied some, that it was always to be found, who had been taught that no such Communication existed. I particularly recollect one instance of this. A very ingenious and well-informed American,

“ Mr

“ Mr PHILIP PHYSICK, who got his degree of M. D. at our
“ University two years ago, and who had previously ap-
“ plied closely to the study of Anatomy, and made great
“ proficiency in it, under some of the most eminent Teach-
“ ers in London, requested me to shew him the Communica-
“ tion betwixt the Lateral Ventricles, as he had never been
“ able to perceive it. I did so ; and he viewed it then, for
“ the first time, with much surprize. It is not possible to mis-
“ take it for an accidental laceration, the edge is so ex-
“ tremely neat, smooth and regular. No doubt, it is more
“ distinct in some instances than in others ; and it may be,
“ that, if the Ventricles were only just moist or without any
“ sensible quantity of liquid collected in them, the surfaces
“ consequently quite contiguous to each other, it should not
“ be very apparent, and might therefore be overlooked by
“ one prepossessed with the idea that no natural communica-
“ tion did there exist. But I have never seen the Brain in
“ such state, but that it was very easy to perceive it. When
“ water is preternaturally collected in the Lateral Ventricles,
“ it is sometimes observed to be contained in much greater
“ quantity in one of them, than in the other ; and I have
“ seen one of the Ventricles much enlarged and full of water,
“ while the other remained of its natural capacity and con-
“ tained hardly any water. This appearance I should, how-

“ ever, impute, not to the obliteration or obstruction of the
 “ communication betwixt them; but to one side of the Brain
 “ having been more affected with disease, more flaccid and
 “ tender, than the other; in consequence of which, a greater
 “ exudation had taken place from the vessels of this part,
 “ and the sides of the Ventricle had yielded more readily to
 “ the pressure of the water as it was effused.

“ I remain, with much respect and esteem,

“ Dear Sir,

“ Your most obedient humble servant,

EDINBURGH, }
 14th August 1794. }

“ D. RUTHERFORD.”

As the Human Anatomy is generally illustrated by a Com-
 parison with other Animals, I next dissected the Brain of the
 Ox and of the Sheep, in the same manner; of which Mr.
 FYFE drew accurate Figures. These were compared with the
 Dissected Brains by three of my Colleagues, to wit, Dr GRE-
 GORY,

GORY, Dr RUTHERFORD, and Dr DUNCAN ; who allow me to add, that they were equally satisfied with the Accuracy of these Figures.

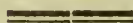
I found, that in these Animals, (and I have since observed the same in the Horse and in the Whale), the middle parts of the Thalami Nervorum Opticorum are incorporated intimately, and hence, from the Passage by which the Lateral Ventricles communicate with each other and with the Third Ventricle, there is a Passage above, as well as below, the joining of the Thalami.

As this joining, and all other circumstances of the structure, are so nearly the same in the Ox, the Horse, and the Sheep, I think it sufficient to publish the Figure taken from the Ox.

EXPLANATION

OF THE

T A B L E S.



IN the description I am about to give of these Tables, I shall place the Letters to which I refer, on an Outline of the Tables.



Explanation of Table First.

THIS Table represents the Human Cranium and Encephalon, cut perpendicularly at the right side of the Falx and Septum Lucidum.

A A Represents the Section of the Cranium.

B A Section of the Right Frontal Sinus.

C

TAB. I.







- C The Forepart of the Falx, fixed to the Crista Galli.

- D The Backpart of the Falx, fixed to the Middle of the Tentorium, E.

- F The Upper and Anterior Part of the Cerebellum.

- G Part of the Inner-side of the Left Hemisphere of the Brain, with Arteries upon its surface from the Anterior Branch of the Internal Carotid Artery.

- H H A Section of the Corpus Callosum.

- I I The Septum Lucidum, between the Lateral Ventricles, in which there is no Hole.

- K The Middle Part, or Body, of the Fornix.

- L A Section of the Right Posterior Crus of the Fornix.

M

- M A Section of the Right Anterior Crus of the Fornix.
- N The Left Anterior Crus of the Fornix.
- O A Section of the Anterior Commissura Cerebri.
- P The Inner-side of the Left Thalamus Nervi Optici, forming the Left Side of the Third Ventricle.
- Q A Vein running on the Right Side of the Forepart of the Septum Lucidum, and then across the Forepart of the Body of the Fornix, to terminate in the Choroid Plexus, R, under the Body of the Fornix, to which the Choroid Plexuses of the two Lateral Ventricles are united.
- S An Oval Hole, situated under the Anterior Part of the Body of the Fornix; behind the Anterior Crura of the Fornix and Commissura Anterior Cerebri; on the Forepart of the Joining of the Choroid Plexuses of the two Lateral Ventricles of the Brain; and over the Forepart of the Third Ventricle. Hence,
at

at this place, the Lateral Ventricles of the Brain communicate with each other and with the Third Ventricle.

- T The Left Optic Nerve cut away from the Right at the place of their Junction.
- U A Blind Sac in the Left Side of the Third Ventricle; under the Commissura Anterior, and between the Continuation of the Corpus Callosum and the Joining of the Left Optic Nerve with its Thalamus.
- V The Iter per Infundibulum ad Glandulam Pituitariam, between the Joining of the Optic Nerves with their Thalami and the Corpora Albicantia; a Section of the Right one of which is represented at W.
- X A Section of the Tuber Annulare.
- Y The Pineal Gland, fixed by a Peduncle on each side to the Thalami Nervorum Opticorum, and by a middle Peduncle to Z, the Commissura Cerebri Posterior.

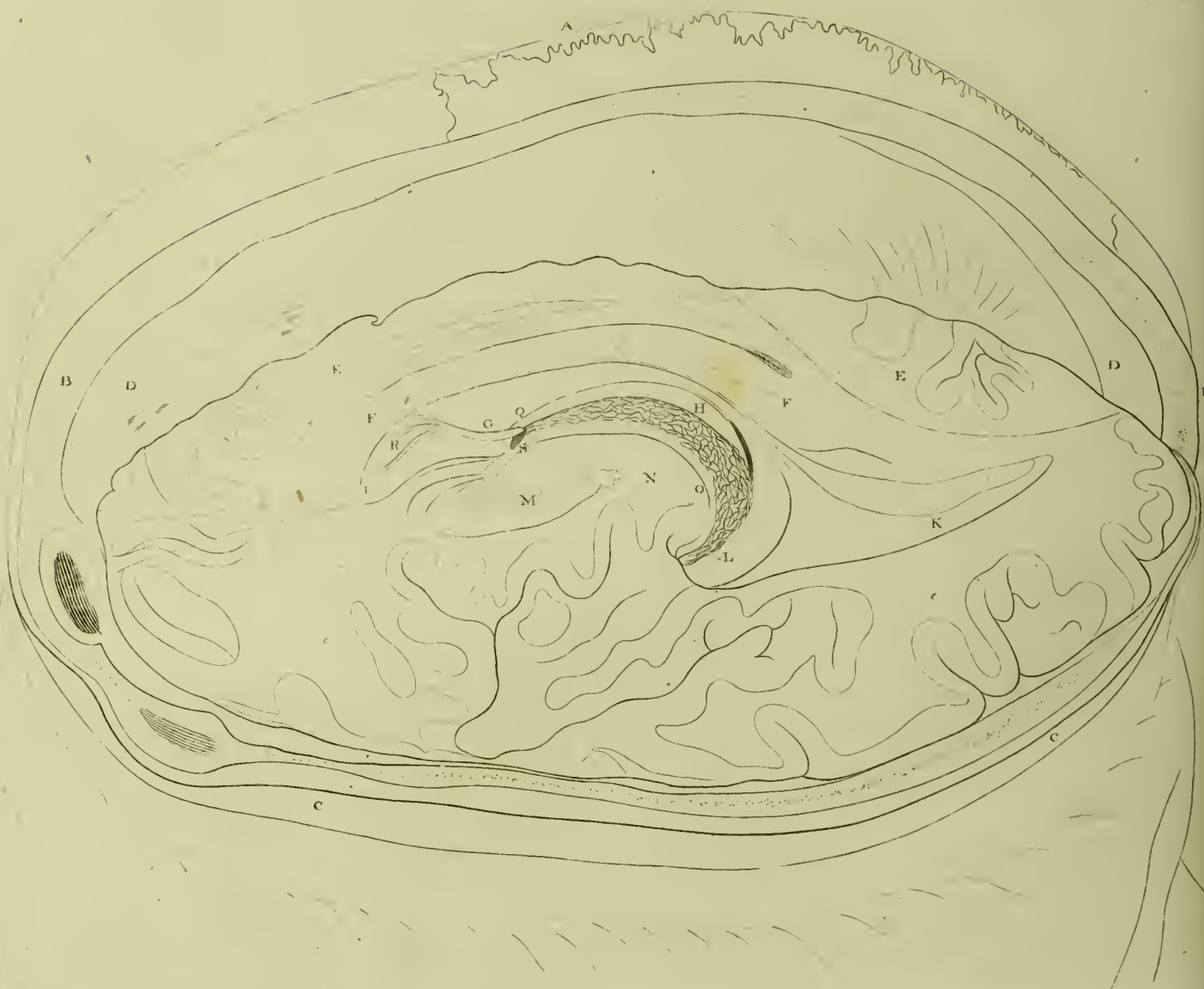
- a* The Nates of the Right Side cut.
- b* The Testis of the Right Side cut.
- c* The Iter a Tertio ad Quartum Ventriculum.
- d* A Section of the Right Internal Carotid Artery.

Explanation



1. *Life del.*

H. Archibald & Co.



Explanation of Table Second.

THIS Table represents the Cranium and the Left Hemisphere of the Brain of the same subject; cut, first, perpendicularly, about the distance of a finger-breadth from the Falx, to such a depth as to lay open the Left Lateral Ventricle; and then cut, almost horizontally, from the Septum Lucidum and Left Ventricle, to the Outer-side of the Left Hemisphere of the Brain.

A The Sagittal Suture of the Cranium.

B B The Cut Edge of the Top of the Cranium.

C C An Horizontal Section of the Cranium.

D

D D

D D The Left Side of the Falx.

E E The Inner-part of the Left Hemisphere, cut perpendicularly.

e e The Outer-part of the Left Hemisphere, cut almost horizontally.

F F A perpendicular Section of the Corpus Callosum.

G The Septum Lucidum.

H The Middle Part or Body of the Fornix.

I Part of the Anterior Cornu of the Lateral Ventricle.

K The Posterior Cornu of the Lateral Ventricle.

L The Left Pes Hippocampi.

M A Section of the Left Corpus Striatum.

N

- N A Section of the Left Thalamus Nervi Optici.
- O The Choroid Plexus of the Left Ventricle.
- R Veins running on the Forepart of the Septum Lucidum, which pass over Q, the Left Anterior Crus of the Fornix, to terminate where the Choroid Plexuses of the Two Ventricles are joined to the Choroid Plexus under the Body of the Fornix.
- S The Left Side of the Oval Hole or Passage by which the Lateral Ventricles communicate with each other and with the Third Ventricle.

Explanation of Table Third.

THIS Table represents the Cranium and the Encephalon of an Ox, cut perpendicularly on the Right Side of the Falx Cerebri.

A A A Section of the Cranium.

B B The Falx, which is narrower in proportion to the Brain than it is in Man.

C The Inner-side of the Left Hemisphere of the Brain.

D D A Section of the Corpus Callosum.

F





- E The Septum Lucidum.
- F The Middle Part, or Body, of the Fornix.
- G The place from which its Right Posterior Crus was cut off.
- H A Section of its Right Anterior Crus.
- L A Section of the Anterior Commissura Cerebri.
- M A longitudinal Section of the Right Olfactory Nerve, from its Origin to the Ethmoid Bone.
- N A Canal, or Tube, which begins in the Forepart of the Lateral Ventricle, and is continued obliquely downwards within the Optic Nerve, enlarging near to the End of the Nerve. The Inner-sides of it are medullary ; and the End of it, which is shut or blind, is covered with a cineritious Bulb, O ; from which the Fibres of the Olfactory Nerve are derived.

- P A thick Medullary Cord cut, by which the Thalami of the Optic Nerves are united.
- Q The Choroid Plexus under the Body of the Fornix.
- R An Oval Hole by which the Lateral Ventricles communicate with each other and with the Third Ventricle.
- S A Passage leading downwards, between the Anterior Commissura Cerebri, and the Joining or Commissura of the Thalami Nervorum Opticorum.
- T A Section of the Right Optic Nerve where it is joined to its Fellow.
- U A Section of the Right Corpus Albicans.
- V The Infundibulum, between the Joining of the Optic Nerves and the Corpora Albicantia.

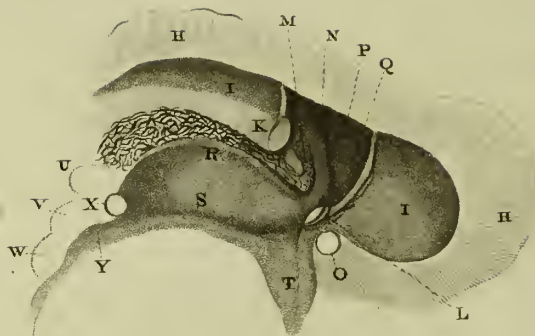
- W A Section of the, Tuber Annulare.
- X The Pineal Gland.
- Y A Section of the Right Nates.
- Z A Section of the Right Testis.
- * A Section of the Cerebellum.
- a* A Section of the Commissura Cerebri Posterior.
- b* A Passage, from the Hole by which the Lateral Ventricles communicate with each other and with the Third Ventricle, leading to *c*, or to the Iter ad Quartum Ventriculum.
- d* The Cavity of the Fourth Ventricle.
- e* The Spinal Marrow, consisting of two principal Cords.

f

f The Bottom of the Fourth Ventricle, shut by its Choroid Plexus and Pia Mater; so that there is no Communication between the Cavity of the Fourth Ventricle and the Cavity of the Spinal Marrow.

C H A P.

TAB. IV.



N. Pyle del.

W. Archibald Sc.

Explanation of Table Fourth.

IN this Table, the Septum Lucidum, and the Fornix, immediately behind its Anterior Crura, are cut across, in order to shew, still more fully, the Passage by which the Lateral Ventricles of the Brain communicate with each other and with the Third Ventricle.

H H A Longitudinal Section of the Corpus Callosum, on the Right Side of the Septum Lucidum.

I I The Septum Lucidum.

K A Section of the Septum Lucidum, and of the Body of the Fornix, behind its Anterior Crura.

L The Right Anterior Crus of the Fornix.

M The Joining of the Choroid Plexuses of the Lateral Ventricles.

D*

N A Part

- N A Part of the Left Tænia, or Left Centrum Semicirculare Geminum.
- O The Section of the Commissura Cerebri Anterior.
- P Part of the Cavity of the Left Lateral Ventricle.
- Q The Bottom of the Passage by which the Lateral Ventricles communicate with each other and with the Third Ventricle.
- R The Joining of the Thalami Nervorum Opticorum, cut.
- S The Left Side of the Third Ventricle.
- T The Passage downwards to the Infundibulum.
- U The Outline of the Pineal Gland.
- V W The Outline of the Right Natis and Testis, cut.
- X The Section of the Commissura Cerebri Posterior.
- Y The Iter ad Quartum Ventriculum.

CHAP. II.

Of the Situation of the Water in the Internal Hydrocephalus.

AN Anatomist, reasoning *à priori*, would be apt to suppose, that the Water, in the Hydrocephalus Internus, should be as often found immediately within the Dura Mater, between it and the Outer-side of the Brain, Cerebellum, and Spinal Marrow, as within the Ventricles of the Brain. Experience, however, proves that it is generally collected within the Ventricles ; and, as I have not met with a single instance in which the Water was entirely on the Outer-side of the Brain, (although I am far from doubting of the possibility of the fact), I cannot help suspecting that this happens much more rarely than is supposed by Authors ; and that in many cases, supposed to have been of this kind, the

E

Brain

Brain had been lacerated in opening the Cranium, and the Water by that means effused on the Surface of the Brain.

In many other cases, where a great quantity of it was collected within the Head, although part of it was, during life, situated on the Outer-side of the Brain, and run out as soon as the Dura Mater was cut; it is certain that the Water had begun to collect within the Ventricles of the Brain, and had escaped from them afterwards in consequence of Changes in the Solid Texture of the Brain, which I shall endeavour to prove, in the next Chapter, frequently take place.

CHAP. III.

Of Changes produced in the Texture of the Brain and Cerebellum, in consequence of Hydrocephalus Internus.

THE disease named Internal Hydrocephalus, in which the Water is at first contained within the Ventricles of the Brain, has been divided by some Authors, not improperly, into two species ; the *Acute*, and the *Chronic*.

In the Acute, the disease generally proves fatal in less than the space of a month ; and it is seldom that more than two or three ounces of Water are found within the Ventricles. From the smallness of the quantity, no uncommon se-

paration of the bones from each other, or opening of the futures, is distinguishable.

In the Chronic species of the disease, the patient survives for many months, sometimes for a year or two. The bones of the Cranium are separated from each other; in some cases to a great distance. In the soft spaces between them, the undulation of a fluid is more or less distinguishable, according to the age of the patient and progress of the disease. In a few cases, I have seen the bones separated to a considerable distance from each other, although the disease did not begin till the child was upwards of two years of age.

In this species, from two to five pounds of Water have often been found within the Cranium; and sometimes a much greater quantity*.

When

* See BONET., Sepulchr. L. i. S. 16. MORGAGNI, Ep. xii. LIEUTAUD, L. 3. S. 5. and others.

When one, two, or three pounds only of Water were collected, it has been generally confined within the Ventricles of the Brain; the sides of which, or substance of the Brain bounding the Ventricles, were observed to be much thinner* than they are in health: And as the Bones at the top of the Cranium are more loosely connected than those at its base, the Substance of the Brain which covers the Ventricles, or the upper part of its hemispheres, is in proportion more dilated than the under part of the Brain. In some instances, the Substance of the Brain appeared to be somewhat indurated; in others, it seemed to be softened.

Where the quantity of Water amounted to five, six, or more pounds, partial Adhesions of the Surface of the Brain to the Dura Mater were observed; at the same time, a quantity run out on opening the Cranium and Dura Mater †.

On

* MORGAGNI, Ep. xii. 5. "Cerebrum Hydrocephalo attenuatum." 8. "Parietum "Laterale Ventriculorum crassitudo vi aquæ extenuata." LIEUTAUD, L. 3. Obs. 322. "A mole aquæ, Cerebrum in ambitu semipollicis crassitiem vix superabat."

† MORGAGNI, Ep. xii. 6. "Aqua ad primam cultri impressionem, cum impetu prorumpens."

On examining farther, the Cortical and Medullary Substances were found to be greatly diminished in their bulk and weight. In some cases, after an enormous Distension of the Ventricles of the Brain, large portions of the solid Substance of the Brain seemed to have been destroyed; and hence, the Water was partly lodged within the Ventricles, and partly between the Surface of the Brain and the Dura Mater *.

In other cases, little remained of the Brain, except its investing membranes, with some of the superficial matter adhering to them; and the osseous matter of some of the bones of the Cranium, was found to be likewise wasted †.

In

* In a case of a Child (C. GILLES, 18 months old,) which occurred in our Infirmary in 1778, five pounds of Water were found, partly within the Ventricles, and partly between the Dura Mater and Brain. The Substance of the Brain appeared soft and flabby; and its texture, in many parts, was much destroyed.

† LIEUTAUD, L. 3. Obs. 326. Miscel. Cur. Tredecem Aquæ libræ intra Ventriculos et totum Cerebrum nonnisi faccum referebat.—327. Ex HILDANO Aquæ libræ

In a foetus Calf, within a few days of the common time of parturition, I found the Cranium enormously dilated, and nearly of a spherical figure. On opening the Cranium and Dura Mater with great care, I found the Arachnoid Coat with the Pia Mater, both of the Brain and Cerebellum, in contact with the Dura Mater, and in some places adhering to it. On cutting these, I found thin and broken-like portions of cineritious-looking substance adhering to them; and, within this, upwards of fifteen pounds of a transparent watery liquor, a small proportion only of which coagulated on boiling it. I afterwards cut out all the membranes of the Brain and Cerebellum, with the cineritious-looking matter adhering to them, and found that the whole weighed only one ounce and a half.

In

librae octo: ipsummet Cerebrum in sacculum extendebatur, Cranium passim membranofum, potius quam osseum, videbatur.—328. Cerebrum in sacculum extensum.—329. Aquæ copia Cerebrum ferme obliterabat.—332. Ex KERKRING. Cerebri loco, Aqua.

MORGAGNI, Ep. xii. 5. Cerebrum Hydrocephalo attenuatum. — 8. Cerebrum prima inspectione vultum esse videbatur, cum, instar crassioris membranæ, adhæresceret undique arcuatae dissolutorum ossium circumferentiæ. — 8. Radicem Cerebri in fibras unfluxisse.

In Sheep labouring under the disease commonly called the Staggers, I have found a Bag, containing a watery fluid, and bodies which have been supposed to be animated, (and which I have no doubt are so), in one of the hemispheres of the Brain. Over the Bag, the bottom of which was connected to the bottom of one of the Lateral Ventricles, I found the Medullary and Cineritious Substances of the Brain consumed, and the Bag adhering to the Pia Mater, and the Pia Mater with the Arachnoid Coat adhering to the Dura Mater; and over that part of the Dura Mater, the osseous substance of the Cranium was wanting, and a membrane seemed to supply its place. On inquiry, I find, that Sheep-graziers distinguish with certainty the situation of this disease, by feeling a soft place in the Cranium, at which they make a perforation, and endeavour to extract the Sac or Bag; but, as the substance of the Brain is deeply affected by the disease, few are saved by the operation.

CHAP. IV.

An Attempt to prove, that the Changes in the Texture of the Brain and Cerebellum, in consequence of Internal Hydrocephalus, are produced by the Absorbent Vessels.

IT has been, so far as I know, the universal opinion of Anatomists and Physicians, that, in the Hydrocephalus Internus, the Substance of the Brain is melted down by the Watery Liquor which is effused from the Arteries.

F

To

To shew that they have thought so, I shall, at the foot of the page, subjoin a few quotations from some of the most eminent Authors*.

As

* BONETI, Sep. L. i. S. 16. Obs. 11. " Nam potuit Cerebrum per redundans
" ferum adeo fuisse emollitum ut mucus esse visum fuerit." S. 16. Ad. Obs. 5.
" Radix Cerebri, a perpetuo illo diluvio et feri incubitu, in fibras diffuxisse vide-
" batur."

MORGAGNI, de Sed. et Cur. Morb. Ep. xii. 5. " Cerebrum in Hydrocephalo at-
" tenuatum et in aquam resolutum."—6. " Quod si Cerebrum fit Hydrocephali
" aqua dissolutum."—6. Verum quacunque ratione et quocunque ex fonte intra Ce-
" rebri thecam aqua præter naturam congeratur; sane poterit, si necdum illud con-
" creverit, ejus concretionem suo interjectu prohibere: aut si jam concreverit; inter
" ejus particulas se insinuando, has sensim magis magisque disjungere, donec ad mi-
" nimas ventum sit, facile cum aqua permiscendas, neque amplius internoscendas."—
6. " In altero Hydrocephalo non solum disjunctionem propemodum perfectam sed
" disjunctarum particularum cum aqua permissionem ipsa indicabit aqua loturæ car-
" nium similis, præterquam et crassum meningem nihil distincti in diffuente cerebro
" videre licuit."

HALLER, in Elem. Phys. L. x. § xxxix. " Quod autem, dissoluto in aquam Cere-
" bro et demum amisso vivatur," &c.

" Eo modo credibile est, sensim quidem Cerebrum contabuisse in aquam."

As a consequence of such an opinion, it should follow, that the Watery Liquor possessed the farther quality of rendering the white and opaque Medullary Substance of the Brain transparent ; and, on evaporating the water, the Medullary Substance should remain in the form of an extract.

But, instead of that, we do not perceive how the water effused into the Ventricles is brought in contact with the medullary or other substance of the Brain, as the Ventricles are lined with thin but dense membrane.—We do not find that we can dissolve the Medullary Substance of the Brain in the Watery Liquor we extract from the Ventricles of the Brain of a person labouring under Hydrocephalus.

When we heat and evaporate the Watery Liquor collected in Hydrocephalus, we are so far from recovering the medullary substance of the Brain, that very little coagulable or solid matter is found in the residuum ; for the quantity even of the coagulable lymph is less in this than in most other species of Dropsy*.

F 2

Similar

* BONETI, Sep. L. i. S. 16. Ad. Obs. 12. De Hydrocephalo, " Aquæ, in cochleari ferreo, nonnihil prunis imposuimus. Non in gelatinam concrêvit, uti aqua in ventre Hydropicorum solet, sed, post evaporationem, sal acre reliquit."

Similar Watery Liquor, effused in the other species of Dropsy, is not found, nor supposed, to possess any such solvent power.

I apprehend, therefore, that this hypothesis is to be entirely rejected; and, that instead of supposing that the parts of the Brain disappear because they are melted down by the Water, and rendered pellucid, we are to imagine, that the parts of the Brain are carried off by the Absorbent Vessels; which are excited to unusual action, by the tension and irritation which the Water occasions.

In a case, very different from Dropsy, to which I was called, in 1784, along with Dr CHARLES WEBSTER, I have likewise seen undoubted proof, that a great part of the solid substance of the Brain must have been carried away by the Absorbent Vessels. The Patient, a stout man, about thirty years of age, had, for ten months, complained of the most excruciating pain in the right side of his Forehead. At last he was seized with delirium, which terminated in stupor and apoplexy; and in this state I found him. He died next day. On opening his Head, the Left Hemisphere of the Brain was found to have its usual appearance; but the
Anterior

Anterior Lobe of the Right Hemisphere was of a deep purple colour, very considerably indurated, and adhered firmly to the Supra Orbital Plate. On cutting it perpendicularly into two parts, which I preserve, the distinction of Cineritious and Medullary Matter was scarcely observable; for the whole of it was of a dark purple colour, nearly uniform in texture, and had large and numerous vessels, filled with red blood, in its composition resembling the Lungs in an inflamed state more than the Brain.

There was no effusion of water or of blood, nor collection of purulent matter. It was therefore evident, that, in proportion to the enlargement of the Blood-vessels, and perhaps increase of their number, there must have been an Abstraction of the Cineritious and Medullary Matter made by the Absorbent Vessels.

As the Cortical and Medullary Substances of the Brain are not evidently compressible, it follows, that in the cases of Sudden Apoplexy, Epilepsy, Suffocation from Noxious Vapours, Drowning, Hanging, there can be no such sensible general Enlargement of the Blood-vessels as has been supposed and described by Authors. But if, by long-continued
intemperance,

intemperance, or other causes, the Blood has been circulated within the Head with more than usual violence, there may have been an increased Absorption or Wasting of the solid Substance of the Encephalon; and, in proportion to that, an Enlargement of the Blood-vessels, and evident Increase of the Quantity of Blood within the Head.

C H A P.

CHAP. V.

Circumstances enumerated, which prove,
That the Solid Parts composing the
other Organs of our Body are Ab-
sorbed.

THAT the Solid Matter of the Brain can be carried off by the Absorbent Vessels, appears, at first sight, an opinion so incredible, that I shall endeavour to support it by the following Observations,—which, I apprehend, prove beyond a doubt, that the Solid as well as the Fluid Parts of Animals are under a constant state of Change.

a. The

a. The Several Glands and Glandular Viscera are often enlarged and indurated, remain in that state for a considerable time, and sometimes return to their natural size and recover their found structure.

b. Hemorrhoidal Tumours, which I have found to contain a great deal of solid matter, instead of being entirely produced, as MORGAGNI and HALLER have affirmed*, by a varicous state of the Veins, after increasing to considerable bulk, disappear almost entirely, leaving nothing but the skin which covered them.

c. Venereal Excrescences, called Fici, Mori, &c. are often removed by the internal use of Mercury.

d. The glandular body called Thymus, generally disappears, or is absorbed, before the sixteenth year of life.

e. Where

* MORGAGNI, Ep. xxxii. 10, 11.

HALLER, El. Phys. T. vii. lxxiv. S. iv. § xii. p. 193.

e. Where the Skin is extended, and at the same time irritated, by an abscess forming under it in the condensed cellular substance, it is wasted, and sometimes breaks into holes, several days before the purulent matter contained in the abscess is discharged, that is, before the matter is in contact with the skin.

f. In like manner, the Fleshy Parts of the Muscles sometimes shrink greatly, lose their red colour and fibrous appearance, and seem to be converted into white-coloured tough membranes. I have long had in my possession a preparation, in which a large portion of the Apex of the Left Ventricle of the Heart of a Man has entirely lost its Fleshy Structure, and has the appearance of a white, tough, thin membrane. Within this part is contained a whitish firm Grume formed by the blood, such as is found in Aneurismal Sacs. — In other instances, the whole Fleshy Part of a Muscle is removed, without the application to it of fluid or acrid matter, which could be supposed to have corroded or melted it down into a liquid state. A remarkable example of this kind occurred about twenty years ago, in the case of an eminent Physician, Dr AU——N, whom I attended along with Dr HAY and the late Dr HOPE, and who, for upwards of a year before his death, had been distressed with

G

pains.

pains in the intestines. On opening his body, we found, to our surprise, that the distended Sigmoid Flexure of the Colon was firmly united with the Skin, and that the Abdominal Muscles were entirely removed from a space larger than the whole hand could cover.

In Old Persons, I have repeatedly found, that the Cavities of some of the *Bursæ Mucosæ* which are contiguous to Ligaments, communicated with the Cavities of the Joints, in consequence of a Wasting of the Membranes of the *Bursæ* and Ligaments. These Persons had not, in life, complained of pain; no acrid, purulent, or other liquor, was collected; the sides of the holes by which the communications were made, were not ragged, but smooth; no lacerated membranes were found floating in the *Bursæ* or in the Joints: The Waste, therefore, could only have been produced by the gradual Absorption of the Particles which had composed the Membranes.

g. But the most striking proofs that the Solids may be Absorbed, are to be drawn from attention to the Structure and Growth of the Bones, and to their Waste by age and disease.

b. When Powder of Madder is mixed with the ordinary food of an Animal, it communicates its colour to the clear
part

part of the Blood, and soon thereafter the Bones are tinged. The Red Colour of the Bone, in some degree, depends on the Particles of the Madder mixed with the Blood in the Vessels of the Bone; but as I have found, that the Colour is little, indeed not sensibly, changed by injecting pure water into the Vessels, and washing the Blood out of them, it is certain, that the Colour is chiefly owing to a Red Earthy Matter which has been added to the Bones whilst the Animal was fed with the mixture of Madder. If the Madder be withdrawn from the food of the Animal, the Red Colour disappears, which can only be by its Absorption.

i. The Skeleton of a very Old Person is so much Lighter than that of a middle-aged person of the same stature, that the difference cannot be accounted for on the common supposition that the Solids are compacted, and the Fluids alone absorbed.

k. On comparing a considerable number of Skulls of very Old Persons, with an equal number of those of Middle Age, I have found, that they had lost about Two Parts of Five of their Weight.

l. In the Jaw-bones of Old Persons, besides their general loss of weight in common with the other bones, the Sockets of the Teeth, after these drop out, are removed entirely; so that the Lower Jaw-bone loses nearly one half of its depth, and, upon the whole, more than one half of its weight.

m. In the Aneurism of the Arch of the Aorta, of which many cases are in my possession, the Sternum, the Ribs, their Cartilages, the Cartilages of the Trachea are altered in their shape, and wasted in their substance, long before the Blood gets into contact with them; which must be owing to an increased Absorption.

n. In Venereal Cases, the Bones sometimes swell considerably, or Nodes form upon them, both of which effects are often dispersed by Mercury.

o. In a very large collection of Morbid Bones in my possession, whilst, in many instances, their thickness and weight are much greater than in sound bones, in others, their weight is greatly diminished.

p. In some cases of Ulcerous Caries affecting the lower end of the Tibia and Joint of the Ankle, I have found, after

ter amputation was performed, that the Bones of the Tarsus and Metatarsus, at a distance from the ulcer, were much Softer and Lighter than in a sound person of the same age.

q. In Rickets, although the Bones, and particularly their Extremities, are enlarged, yet the Skeleton of a Rickety Child is commonly Lighter than that of Children of the same age who are killed by other diseases.—In some cases of Rickets, the Bones become not only thicker but heavier than in the sound state: In proof of which, I have in my possession the Parietal Bones of a Rickety Person which are upwards of an inch in thickness.

r. In the disease called Incarnation of Bones, because they are soft and may be cut like flesh, the Bones become semitransparent, and extremely light; and, in some cases, whilst these changes were going on in them, it was observed that the Urine deposited a large quantity of a White Plastery-looking Sediment; to which is added, in one case of a Woman, of the name SUE, that before the disease began, she had been in the habit of devouring daily a great quantity of Sea-salt. There can be no doubt, therefore, that, in this disease, the Earthy Matter of the Bones is carried

ried off by the Abforbing Veffels: In confequence of which, thofe Bones, or Parts of Bones, which naturally are the hardeft, or have the greateft quantity of Earth in their compofition, are by this difeafe rendered the foftest.

/. From the whole, it appears, not only, that the Solid Parts of the Body may be Abforbed in confequence of Dif-eafe; but, that in Health, and during the whole Courfe of Life, there is fuch a conftant Interchange of the Particles which compofe the Solids, by means of the Veffels which Secrete and Abforb, as to render it doubtful whether a fingle Atom remains in our Bodies which formed a part of them fome years ago.

C H A P.

CHAP. VI.

At what Time the Circumstances enumerated in the last Chapter were first taught by the Author.

OF late years, the Absorption of the Solid Parts of Animals has been mentioned by a few Writers who have published in London: And as Mr JOHN HUNTER has been quoted by some of them, as the Author of this Doctrine, I must here observe, that so far back as the year 1759, and ever since that time, I have mentioned, in different parts of my annual Course of Lectures in this University, all the Circumstances above mentioned which relate to the Bones, and
likewise

likewise several of the Circumstances which appeared to prove an Absorption of the other Solid Parts; and, particularly, I endeavoured to explain, on this principle, the Changes which are produced on the Sternum and Ribs by Aneurism, which Dr WILLIAM HUNTER, at that time, accounted for, on the erroneous supposition, that these Bones were melted down by the current and solvent power of the Blood. See Med. Obs. and Inq. vol. i. 1757, p. 344. “ But “ in this case,” says he, “ the appearance was rather as if “ the Blood had insensibly dissolved and washed away the “ Substance of the Bone, making greatest havock in the “ softest part of the Bone, as we see in stones of unequal “ texture that have been long washed by a dropping, or a “ stream of water. Has the Bone that property which some “ have ascribed to it, of dissolving Bony Matter ?” &c.

It is plain, then, either, that Mr JOHN HUNTER had not, at that time, proposed the Doctrine of the Absorption of Ossæous Matter; or, if he did so, that his Brother was ignorant of it, or paid no regard to it.

When, near twenty years thereafter, Mr JOHN HUNTER mentioned such an opinion in his Lectures, it appears, from the testimony of a very sensible and ingenious gentleman,
(Dr

(Dr WINTERBOTTOM), who attended him then, and who, in his Thesis, has shewn his disposition to do him justice, that he rested his opinion chiefly, if not solely, on the circumstance, that in Growing Animals the Medullary Canal is enlarged in its diameter ; which he took for granted must be owing to an Absorption of the Internal Layers of the Bone, whilst new Layers were adding to its external part ; not knowing that the celebrated Du HAMEL has, upwards of half a century ago, proved by the following simple and decisive experiment, That the Diameter of a Bone, as well as that of its Medullary Canal, is increasing in Growing Animals, by an Extension of the several Layers which compose it. See Mem. de l'Acad. des Sc. 1743, p. 102. “ J'en-
 “ tourai l'Os d'un Pigeonneau Vivant avec un Anneau de
 “ fil d'argent, qui étoit placé sous les Tendons et sur le Pe-
 “ riofte. Je laissai là cet Anneau, pour reconnoître ce qui
 “ arriveroit aux couches Osseuses déjà formées, supposé
 “ qu'elles vinssent à s'étendre ; car je pensois que mon An-
 “ neau étoit plus fort qu'il ne falloit pour résister à l'effort
 “ que ces lames Osseuses feroient pour s'étendre. Il résistoit
 “ en effet ; et les couches Osseuses, qui n'étoient pas encore
 “ fort dures, ne pouvant s'étendre vis-à-vis l'Anneau, se cou-
 “ perent. Ce qui prouve bien l'Extension des Couches Os-
 “ seuses, c'est qu'ayant disséqué la partie, je trouvai, que le

H

“ Diametre

“ Diametre de l’Anneau n’étoit pas plus grand que celui du
 “ Canal Medullaire.”——To shew still more clearly, that
 Mr JOHN HUNTER had built his opinion on an erroneous
 foundation, I have remarked, in many Diseased Bones in
 my possession, in which the Thickness of the Bones is great-
 ly increased, that the Medullary Canal is much diminished.
 ——From this, and from DU HAMEL’s experiment, then, we
 may observe, that the Plates of the Bones may be extended
 in all directions, or, that they grow in length, breadth, and
 thickness.

Dr WINTERBOTTOM, after attending Mr JOHN HUNTER’s
 Lectures, studied the usual number of years in this Univer-
 sity, and received the Degree of Doctor of Medicine, in
 1781, after publishing an excellent Dissertation, *De Vasis*
Abforbentibus.

In this, p. 27. he writes as follows :

“ § 34. Abforbentia, Fluida sorbere, jamdiu notum ; glo-
 “ ria autem monstrandi ea Solida quoque haurire, penes
 “ MONRO Anatomicum peritissimum est. In hanc senten-
 “ tiam, uti jamdudum in Prælectionibus prædicavit, multis
 “ argumentis adductus ibat : Sed præsertim, quia Thymum
 “ glandulam

“ glandulam evanescere ; Ossâ Senis multo leviora quam Ju-
 “ venis esse ; Terram Rubram, quam Rubia Tinctorum in
 “ Ossâ infert, post aliquod tempus auferri ; etiamque variis
 “ in morbis Ossâ mollia, distorta, fere pellucida, et levia, de-
 “ venire ; imo, aliquot in exemplis, insolitam quantitatem
 “ Sedimenti Albidi, Terræ Ossium simillime, in Urina fuisse
 “ inventam, — animadvertit.

“ In Prælectionibus, de eadem re, observavit cl. JOANNES
 “ HUNTER, “ Quamvis difficile comprehensu sit quomodo
 “ Vasa possint Solida amovere, æque tamen difficile compre-
 “ hensu quomodo ea formare possint, quod nihilo feciùs ferè
 “ omnes credunt.”

“ § 35. Solida non minus quam Fluida absorberi, pro
 “ certo affirmare haud cunctor ; namque Ossâ Hominis, me-
 “ dia ætate, plus Ponderis quam Senilia, æque ampla ha-
 “ bent. Quibusdam in exemplis quoque Atrophix et Tabis,
 “ partem ossium esse absorptam, inter Auctores omnes con-
 “ venit.

“ § 36. Hanc rem JOANNES HUNTER quàm pulcherrimè
 “ sic illustrat, (*in Prælectionibus) : “ In Ossè Femoris In-

“ fantis, Cavitas initio perexigua est ; corpore autem cre-
 “ cente, amplior evadit : Ita, dum Arteriæ Terram Offis
 “ externæ parti adjiciunt, Absorbentia eam internè ad-
 “ imunt.”

Dr WINTERBOTTOM adds, in a Note †, “ Hoc aliter ex-
 “ plicari posse equidem non nego ; sed opinio modò posi-
 “ ta, etsi non omninò certa, pulchra faltem mihi vide-
 “ tur.”

C H A P.

CHAP. VII.

Of the Cure of Internal Hydrocephalus by Medicines.

AS, probably, the Particles composing the Solids of our Body are dissolved by Secreted Fluids, or reduced to a Fluid State before they be fit for being absorbed ; and as, therefore, the Waste of the Solids, by the Absorption of them, must be performed by a much more complex process than that of Fluids ; we should, after finding proof that the Cineritious and Medullary Matter of the Brain can be removed by it, be apt, at first sight, to suppose, that the Internal Hydrocephalus could be easily cured by Medicine. But, when.

when we reflect, that the Distension and Irritation, which create the unusual exertion of the Absorbent System, seem to operate still more powerfully on the Secerning Vessels, and that whilst the Absorbents are preying on the Solid Matter of the Brain, the Effusion of the Watery Liquor is increasing rapidly, we begin to perceive, that the Cure must be much more difficult than we had supposed it to be: And, as we find, by experience, that Irritation greatly increases the discharge from exhaling vessels, I have often thought, that the singular Sensibility of the Parts of the Brain, highly excited by the Distension of its Ventricles in Hydrocephalus, must, in it, render the chance of Cure far less than it is in other species of Encysted Dropsy.

Of late years, Mercury has been much extolled for the cure of Hydrocephalus Internus; and various cases of success with it; even after the disease had made considerable progress, have been published.

I shall subjoin a Summary Account of the Cases in which I have made trial of it.

Since the month of August 1779, I have attended Twenty-two Patients, labouring under Internal Hydrocephalus, to whom

I

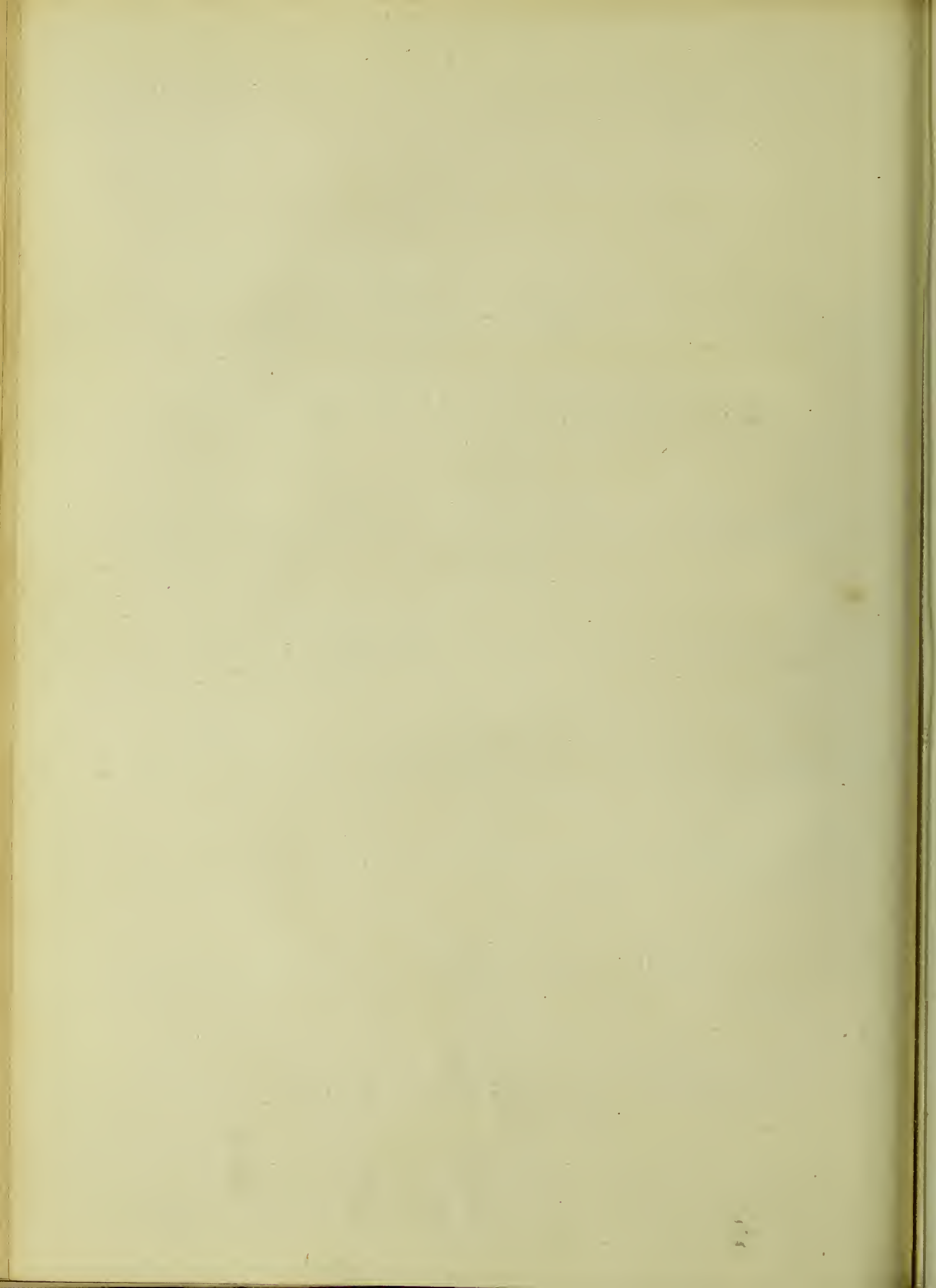
I have given Mercury. — Of these, Fifteen were Males, and Seven Females. — Twelve of them were under Seven years of age: Nine of them were from Eight to Fourteen years of age: One was Twenty-three years old. — Four of them lived Five Days only after I was called: Nine of them survived Seven or Eight Days: Three of them survived Ten Days: Five of them survived Thirteen or Fourteen Days: One, Six years of age, survived Four Months, without any sensible Enlargement of his Head.

In treating these cases, I generally began with the application of Leeches to the Temples. I then gave Calomel, in such quantity as to act as a brisk purgative. I applied a large Blister to the Top of the Head. In some cases, I kept a portion of the blistered part open as an Issue. In others, I applied Blisters in succession to different parts of the Head. In all of them, I directed, that strong Mercurial Ointment should be carefully rubbed upon the Skin of the Legs or Arms, morning and evening: And, in severals, I added Doses of Calomel by the Mouth; taking care not to give so much of it as to occasion purging. — In some cases, I combined the Powder of Squills with the Calomel; and in a few, the Powder of the *Digitalis Purpurea*.

In Four of these cases, the Gums became Red, but with little swelling: In Four others, the Gums were not only Red, but considerably swelled. In Two cases, there was a free Salivation. In the Boy, six years old, who survived four months, a profuse Salivation was kept up for seven weeks; yet, after his death, Eight Ounces of Water were found in the Ventricles of the Brain, by Mr GULLON, Surgeon in Dunfermline, under whose care he was after the Salivation. — In none of the other cases, were the effects of the Mercury distinguishable.

As, in the greater number of the above cases, the disease had made considerable progress before I was called; and as most of the Patients survived but for a short time thereafter; the Effects which the Mercury may have, if given on the first appearance of the symptoms, are by no means fully determined. And, as I have repeatedly found, in other dangerous species of the Natural Encysted Dropsy, particularly in Hydrothorax and Ascites, that Mercury, combined with Squills or other diuretic medicines, in such quantity as to salivate in a slight degree, contributed much to the relief or cure of the Patient; I would recommend the farther trial of it in Hydrocephalus. At the same time, considering

considering the importance, sensibility, and delicate texture, of the parts which are affected, and total failure in the cases I have described; I cannot help suspecting, that several late Writers are much too sanguine in their expectation of removing Hydrocephalus by the use of Mercury.



CHAP. VIII.

Of the Cure of Hydrocephalus Internus by Chirurgical Operation.

FOUR different States of the Disease may occur, which we shall consider separately.

I. IF, when the disease began, it was not attended with acute pain, and the other common symptoms; for I think there can be no doubt that the Patient must suffer much more distress when the Water is collected within and distends the Ven-

tricles, than where it is effused on the External Surface of the Brain: and if, from a very evident fluctuation of the Water, chiefly at the Bregma, it is supposed, that the Water is situated immediately within the Dura Mater, between it and the Surfaces of the Brain, Cerebellum and Spinal Marrow: we ought to puncture the Dura Mater; as this can be done without danger, may give immediate relief, and may have some chance of producing a cure. The Dura Mater ought to be punctured cautiously with a Lancet, at the side of the Bregma, or as far as possible from the Superior Longitudinal Sinus.

In my Book on the Nervous System, Chap. iv. Sect. 3. I have given the history of one attempt of this kind, which I directed; and shall here refer the Reader to it.

2. IF the Water be collected, in small quantity, within the Ventricles, which is almost always the case in the Acute Hydrocephalus, the deep Wound of the Substance of the Brain, which must be inflicted in order to reach the cavity of the Ventricles, would probably prove fatal directly, or indirectly by exciting inflammation: or, if it should
neither

neither immediately prove fatal, nor excite inflammation, the Water would soon be again collected ; and, of course, the disease would, ere long, terminate in death.



3. IN the Chronic Species of Internal Hydrocephalus, where the Head is enlarged by Water, which has been gradually collecting, and is still entirely confined within the Ventricles of the Brain, some Authors have proposed, and, in a few cases, have ventured, to discharge the Water by puncture with a Trocar. But, within a few hours after the operation, every one of their Patients died *.

Upon

* EP. FERDINANDUS, Hist. 1611 "Hydrocephalum infantis incidit, funesto
"eventu."

G. FABRICIUS, Cent. iii. Obs. 17. "Ab Hydrocephalo inciso, aperto Bregmate,
"mors."

D. PANAROLUS, in Iatrolog. "In Hydrocephalo, a perforatione cranii mors."

Upon the whole : When we consider the various dangers which must arise from the puncture of the substance of the Brain ; from the unequal bending, pressure, and perhaps laceration of parts, which must happen when the Brain collapses ; from the admission of the air ; from the impossibility of adapting the Cranium exactly to the Brain for its support, by the application of any bandage ; — no prudent Surgeon will embark himself in such an attempt, — “ Ne, “ quem fervare non potuit, occidisse videatur.”

4. If the Water, after having been collected and confined within the Ventricles of the Brain, shall have made its way out of these, in consequence of the destruction of some of the Solid Substance of the Brain by the Absorbent Vessels, so as to be lodged, in part, between the Outer Surface of the

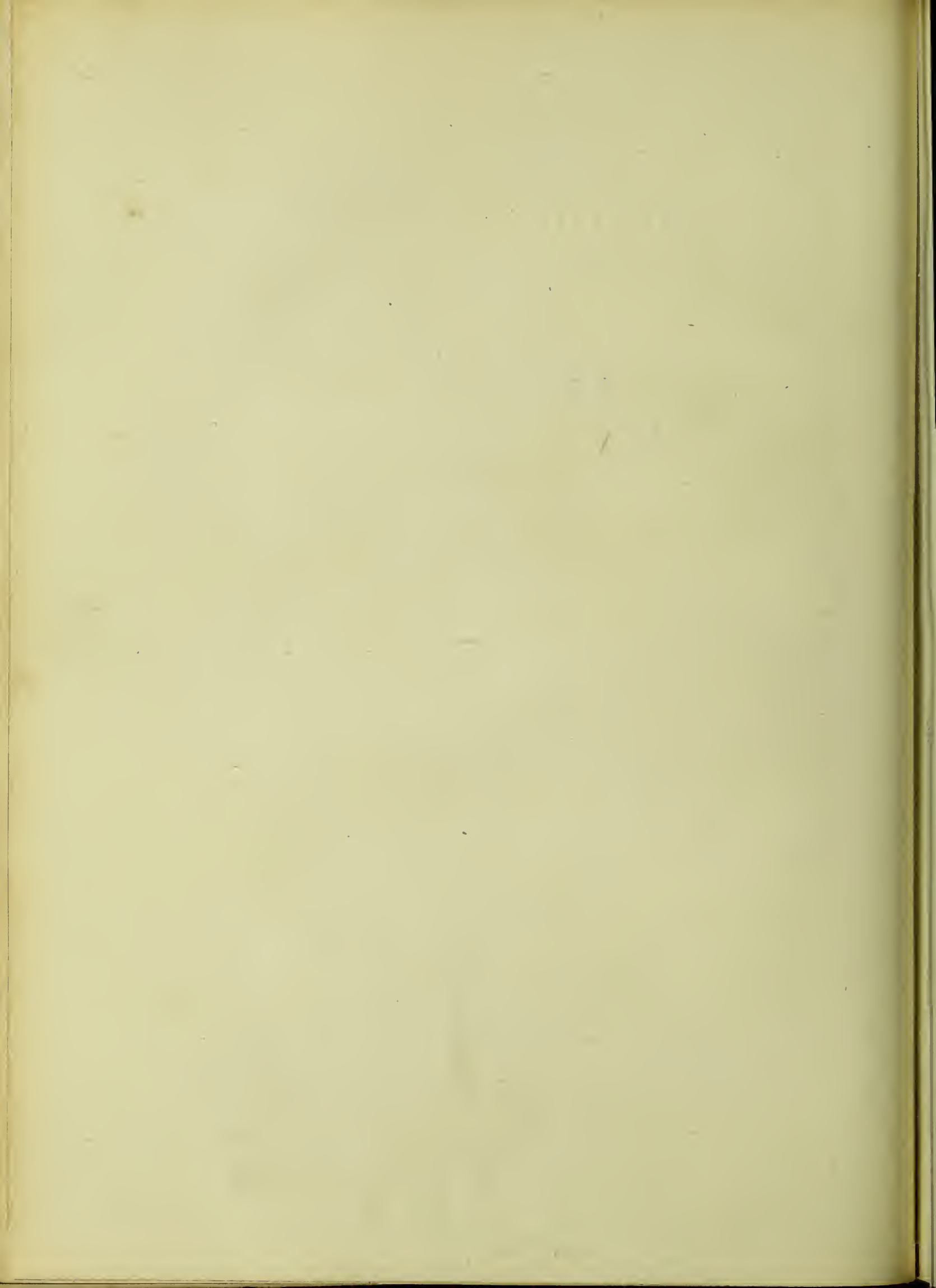
WEPFER, Obs. 49. “ Hydrocephalus, in Puella quinque annorum, infelicitè
“ sectus.”

“ MURALTUS frustra tentavit curationem Hydrocephali incisi.”

Le CAT. Phil. Tr. Vol. xlvii. Art. 40.

the Brain and the Dura Mater, although it may be discharged by a puncture of the Common Teguments and Dura Mater only ; yet, as the substance of the Brain has been materially injured by the disease, the case is evidently, in all other respects, more desperate than the former.

THE END OF TREATISE FIRST.

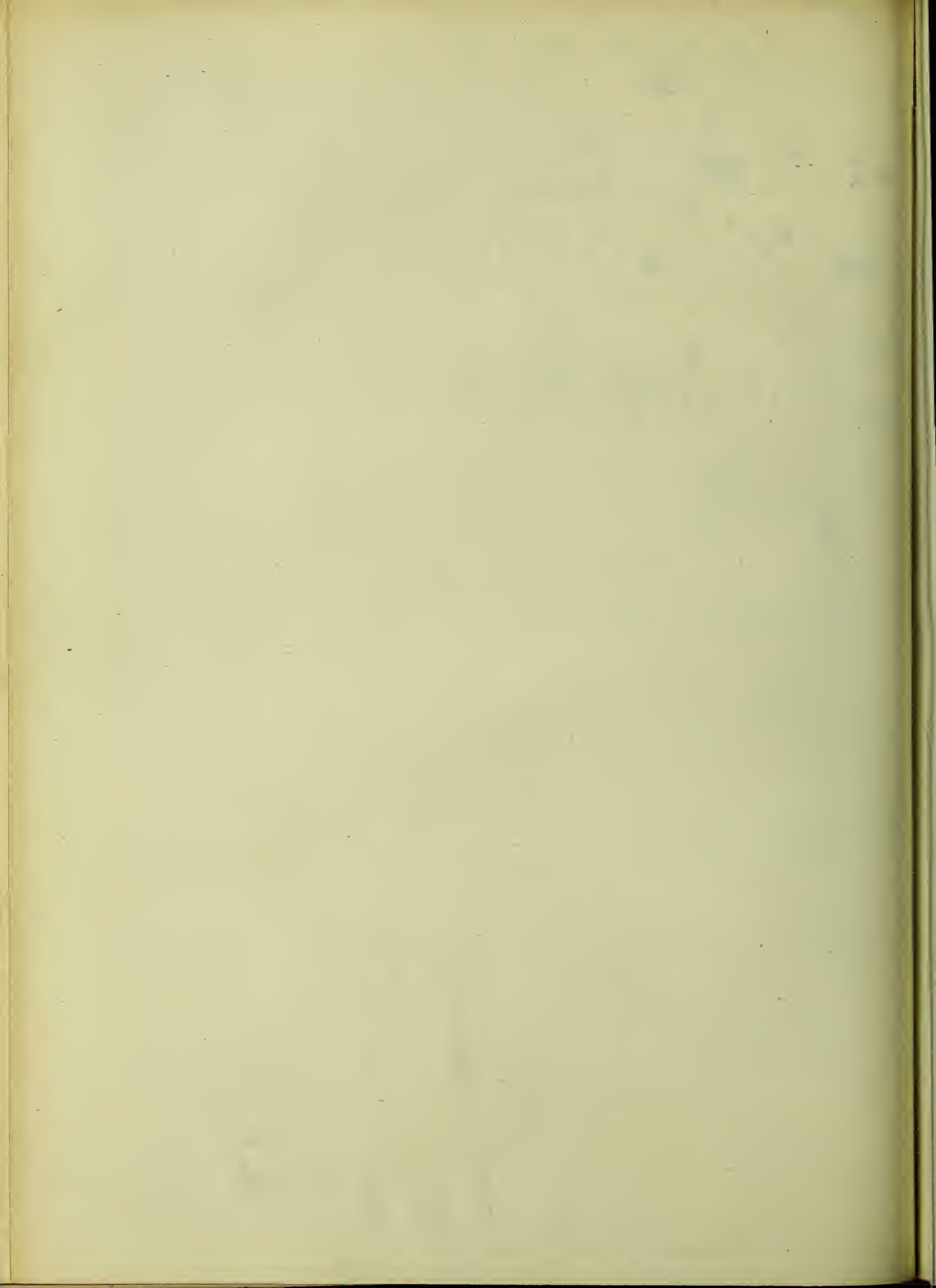


MISCELLANEOUS
OBSERVATIONS
ON THE
STRUCTURE AND FUNCTIONS
OF THE
EYES.

BY
ALEXANDER MONRO, M. D.
PROFESSOR OF MEDICINE, ANATOMY, AND SURGERY,
IN THE UNIVERSITY OF EDINBURGH.

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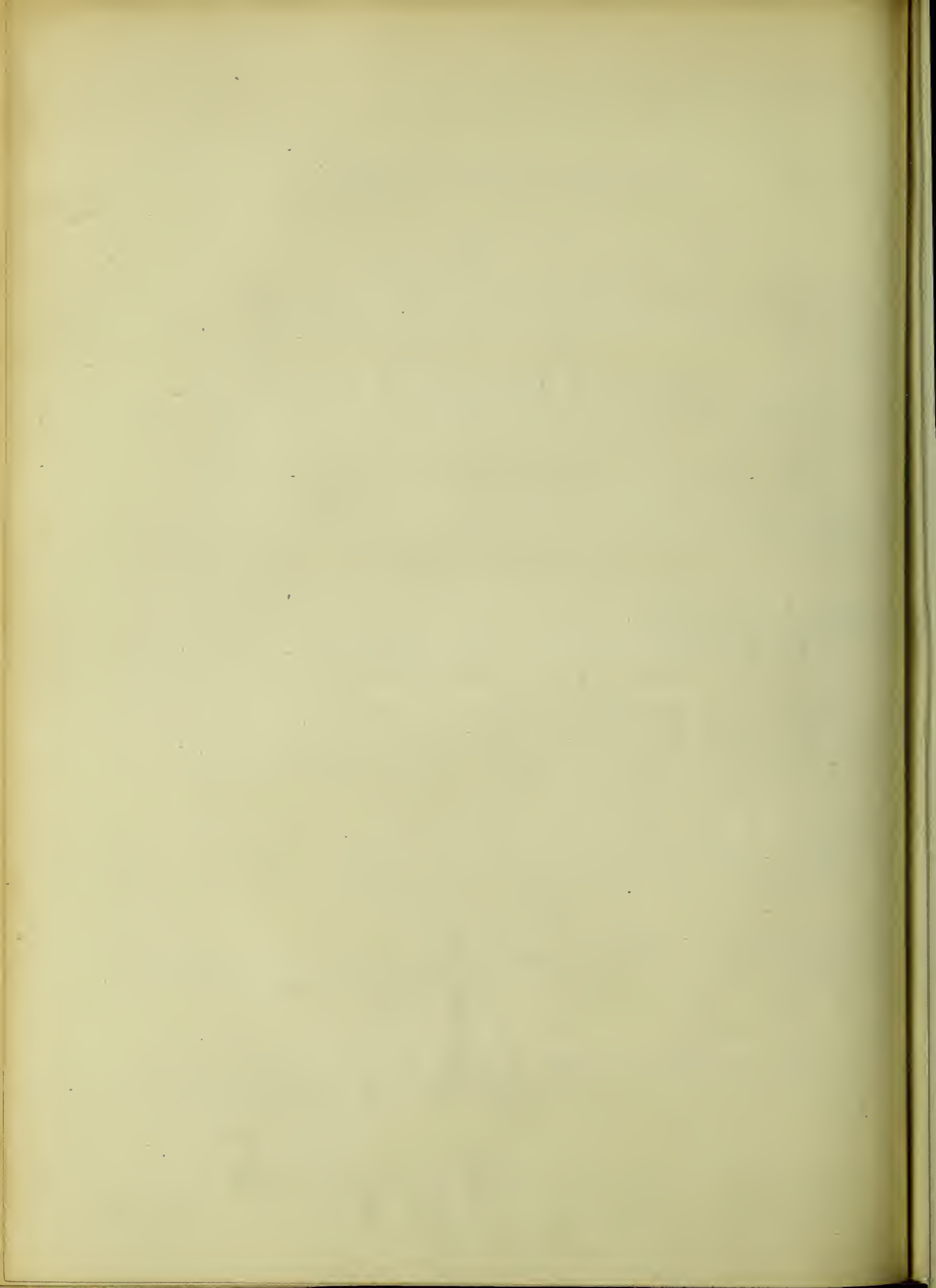
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TREATISE SECOND:
OF THE EYES.

INTRODUCTION.

IN this Paper, I shall briefly state some material circumstances, respecting the Structure and Functions of the Eyes, which have escaped the observation of Authors; or, concerning which, erroneous opinions have, I apprehend, been entertained by them: And I shall begin with Remarks on the Humours of the Eye, and from these shall proceed outwards, as I have found that a Demonstration or Description in this order is the most intelligible.



CHAP. I.

Of the Capsule of the Vitreous Humour.

THE Capsule of the Vitreous Humour, from the Bottom of the Eyeball till it gets forwards as far as to the Roots of the Ciliary Processes, is so extremely thin and delicate, that it can scarcely be demonstrated by Dissection; and, so far, it has very little adhesion to the Retina which covers it.

Within the Roots of the Ciliary Processes, it adheres closely to the Retina; and, a little farther forwards, it seems to divide into two distinct Layers. The External continues to be glued to the Retina, and accompanies it to its termina-

tion, which we shall find to be in the Forepart of the Capsule of the CrySTALLINE Lens, about one-twentieth of an inch from its outer edge : The Internal Layer adheres firmly to the Vitreous Humour, till this is connected with the posterior part of the Capsule of the Lens, at the like distance, nearly, of one-twentieth of an inch from its outer edge ; and at the distance, therefore, of one-tenth of an inch from the connexion of its Anterior Layer and Retina with the Lens. The outer edge, therefore, of the CrySTALLINE Lens, covered with its proper Capsule only, occupies a space nearly one-tenth of an inch in breadth, between the two Layers of the Capsule of the Vitreous Humour.

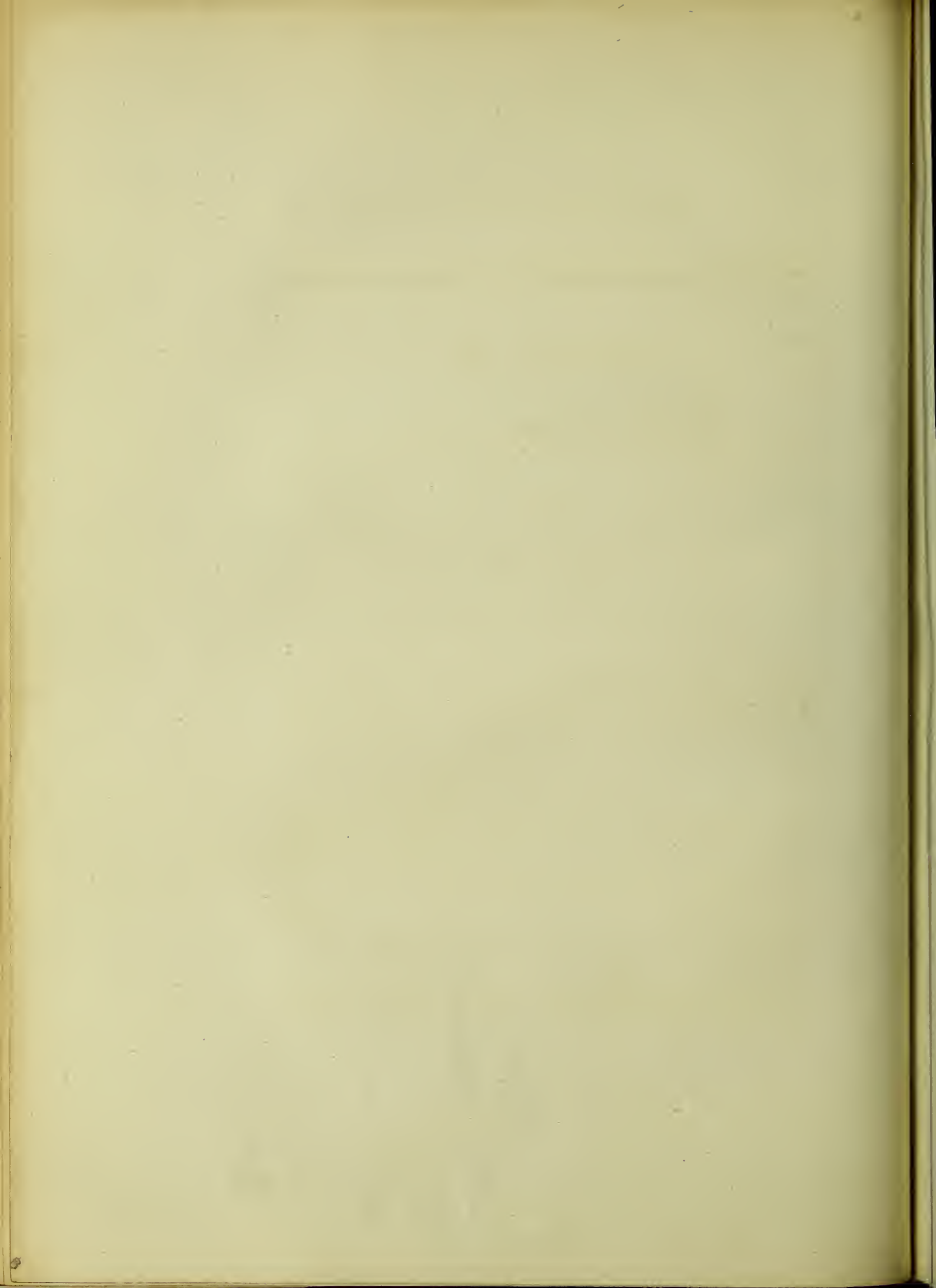
The Anterior Layer of the Vitreous Humour being fixed to the CrySTALLINE Lens, at the distance, nearly, of one-tenth of an inch from the attachment of its Posterior Layer, — a Canal, bounded by the Two Layers of the Vitreous Humour, and by the edge of the CrySTALLINE Lens, as its basis, is formed, which was discovered by Dr PETIT, and is named after him *. Air, blown into this space, passes, of course, around

* Mem. de l'Acad. des Sciences, 1726.

around the Cryftalline Lens. Each of the Two Layers of the Capsule of the Vitreous Humour, is tougher than the posterior part of the Capsule, and adheres firmly to the Capsule of the Lens *.

C H A P.

* See Table I. Fig. 3. 4. 5.



CHAP. II.

Of the Cryftalline Lens.

SECT. I.

Of the Capsule of the Cryftalline Lens.

THE Capsule of the Cryftalline Lens, is of confiderable thicknefs ; but has little toughnefs, or is eafily cut or lacerated.

The Capsule of the Vitreous Humour, by its divifion into the Two Layers I have defcribed, has been fupposed to form it *. But this is an erroneous opinion ; for, it is not only much

* WINSLOW, Traité de la Tête, 235. “ La Capsule Cryftallaine eft formée
“ par la Duplication de la Tunique Vitrée, comme j’ai dit, 229.”

much Thicker than the Capsule of the Vitreous Humour, but is found on the Outer Edge of the Lens, covering that part of it which lies between the Anterior and Posterior Layers of the Vitreous Capsule, and which is not covered by these.

Oculists, founding on the Division of the Capsule of the Vitreous Humour into Two Layers, which pass to the fore and back parts of the Capsule of the Lens, have considered these as Membranes superadded, and loosely connected to the Capsule of the Lens; and therefore pretend to detach the Lens, in its proper Capsule, from the Posterior Layer of the Capsule of the Vitreous Humour, without lacerating it, or breaking the Substance of the Vitreous Humour*. But, in fact, Both Layers of the Capsule of the Vitreous Humour are so intimately connected to, and incorporated with, the Capsule of the Lens, that the Posterior Part of the Capsule of the Lens cannot be separated from that of the Vitreous Humour, without tearing it, and, with it, the Substance of the Vitreous Humour.

S E C T.

* Mr. du WENZEL, on the Cataract, Sect. xxvi.

S E C T. II.

Of the Structure of the Body of the Crystalline Lens, and Whether the Fibres which enter into its composition are Muscular?

It has been long known, that the Crystalline Lens consists of Lamellæ, which are very soft and tender on its surface, but become firmer, tougher, and heavier, as we approach to its centre; and that the Lamellæ are composed of Fibres,

LEEUVENHOEK, who first observed the Fibrous Structure of the Lens, has described them as disposed in a very complex and regular manner, and he supposed them to be Muscular; and this description and opinion have of late been revived.

I had, many years ago, examined and demonstrated the Fibrous Structure of the Lens, in the different Classes of Animals, which I mentioned in my Book on Fishes, Ch. XI.; and, lately, I have repeated my observations, with the aid of the Microscope, without finding that the Fibres are dis-
L posed

posed in the regular manner which has been described and delineated with so much seeming accuracy, or that they can be at all seen till after the Lens is torn or cut: and, besides their Want of Resemblance to Muscle and Tendon, the following arguments appear to me to render the opinion of their being Muscular extremely questionable.

1. After the Crystalline Lens is extracted, the Eye, assisted by a Common Lens, seems capable of adapting itself to different distances. In Two Cases I examined, above twenty years ago, it appeared to be so: At the same time, I must acknowledge I could not trust so entirely to the report of the patients as to be fully convinced of this.

2. I shall, in a following part of this Paper, endeavour to prove, that we possess other means of accommodating the Eye to objects placed at different distances.

3. The External Lamellæ of the Lens, and the Matter which connects the Lens with its Capsule, are so extremely Soft, that such a degree of muscular action of these Fibres as could occasion any alteration of its general shape, could scarcely fail to lacerate the external part of the Lens, and to detach it from its Capsule.

4. In

4. In Fishes, where these Fibres are more manifest than in other Animals, as the Crystalline Lens is nearly spherical, and the Matter composing it nearly incompressible, the Fibres composing its Lamellæ, although they possessed a Muscular Power, could neither change its Spherical Figure, nor render it more Convex by lessening the Diameter or Bulk of the Sphere.

S E C T. III.

Of the Refractive Power of the Crystalline Lens.

It has been very generally supposed, by Anatomists and by Opticians, that the Refractive Power of the Crystalline Lens, compared with that of Water, is proportioned nearly to its density ; or, that its power exceeds that of Water somewhat, on account of the Inflammable Matter which enters into its composition *. But different considerations, and particular-

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ly,

* HALLER, in Elem. Phys. Vol. v. Lib. xvi. p. 402. " Parvam esse quam
 " superat, prærogativam, nuperi fatentur. Erit tamen aliqua, et ex ponderis ra-
 " tione,

ly, that the rays of light cannot be refracted on entering the Cornea in Fishes, and therefore that their Crystalline Lens, which is not more distant from the Retina than in Land Animals, must possess much greater power of Refraction, — having led me to suspect an error in the common opinion, and to put this highly curious point of Physiology to the test of experiment, I discovered, That the Spherical Nucleus of the Crystalline Lens of the Cod, which, in specific gravity, is to Water nearly as 6 to 5, and to common white Glass as 3 only to 10, collects the Light so much more powerfully than Water or Glass does, that its Focus is not more than one-sixth part of its Diameter distant from its Surface; whereas the Focus of the Rays collected by a Glass Sphere, is at the distance of one-fourth of the Diameter of the Sphere; and the Focus of the Rays collected by

“ tione, quæ tamen fere fit ut 11 ad 10, et particularum inflammabilium. Angulum incidentiæ radii ex humore aqueo in lentem venientis, ad angulum refractionis, facit uti 87 ad 85, cl. PORTERFIELD: Eandem rationem æstimat cl. PEMBERTONUS, uti 13 ad 12; et uti 21 ad 20, cl. WINTRINGHAM.” And Dr PORTERFIELD adds, “ This is a surprisngly small refraction, and yet it is as certain as any thing in EUCLID, that it can be no greater.”

by a Sphere of Water, is distant from it one-half of its Diameter *.

On performing a similar experiment with the Human Crystalline Lens, I found, that the Focus, of parallel rays of light falling on it, is at the distance of three-eighths of an inch from its Centre.

But, although this shews, that its powers are far inferior to those of the Lens of the Fish, and even to those of Glafs, which, of the same size and shape, would collect the light at the distance of a quarter of an inch †; yet, as the Specific Weight of the Human Lens does not exceed that of Water above a tenth part, its powers are much greater than have been supposed by Authors; and the Focus formed by the Human Lens, will be found to be situated, nearly, half-way between those produced by Glafs and Water.

C H A P.

* For a more particular Account of my Experiments, I shall refer to my Book on the Structure and Physiology of Fishes, 1785,—Chap. xi.

† In this calculation, I suppose that the Radius of the Sphere of which the Anterior Part of the Lens is a portion, is $7\frac{1}{2}$ lines in length, and that of its Posterior Part 5 lines only.

CHAP. III.

Of the Optic Nerves and Retina.

THE Optic Nerves have, in their whole course, less appearance of a Fibrous Structure than perhaps any other pair of Nerves in the Human Body.

SECT. I.

HENCE, although it appears to me evident, that the Medullary Matter of the Right Nerve is incorporated with that of the Left, where they are connected within the Head, yet I have found it very difficult, if not impossible, to determine
in.

in what proportion of parts the mixture is made, or to trace either of the Nerves, with certainty, from its Origin to its Termination in the Retina.

S E C T. II.

MARIOTTE, above a century ago, has, by an ingenious experiment, proved, that we are insensible of an object if its picture falls on the Entrance of the Optic Nerve into the Eyeball. On repeating this experiment, many years ago, I found, that the Diameter of the Object which disappears is very nearly equal to one-ninth part of our distance from it; or, that, at the distance of Nine Feet from a wall, a Circle One Foot in Diameter is lost. If, therefore, we suppose the Human Eye to be One Inch or Twelve Lines in Diameter, and that the Rays of Light, issuing from the Object, decussate about the Centre of the CrySTALLINE Lens, which is nearly Three Lines behind the Cornea, or Nine Lines from the Retina,—the insensible Spot on the Bottom of the Eye will be One Line in Diameter; and with this calculation I found that the actual measurement of the Medullary Part of the Optic Nerve agrees very nearly.

I next found, that an object begins to disappear, when the point to which the Eye is directed, is One-fourth of the distance of the Eye from it ; and hence, upon the supposition above stated, the Axis of the Eyeball will be found to be Two Lines and a Quarter from the Outer Side of the Optic Nerve, and Two Lines and Three Quarters from its Centre.

S E C T. III.

WHEN the Nerves, after entering the Eyeballs, form the Retina, their Colour is changed from White to Cineritious ; but no Fibres are to be seen in the Human Retina, even with the Microscope ; but the whole appears to be composed of an Uniform Pulpy Matter, on the Outer Side of which, chiefly, Vessels are dispersed, supported, as I suppose, by a Membrane the same with or analogous to the Pia Mater. The term *Retina* is therefore improper, where it is applied to express a Network or Fibrous Texture.

 S E C T. IV.
Of the Termination of the Retina.

Not long after I began to study Anatomy, finding very contradictory accounts of the Termination of the Retina, given by the most eminent Authors*, and even by the same Authors,

* WINSLOW, *Traité de la Tête*, 237.: "C'est peut-être cette continuation qui fait quelquefois paroître les Feuilletés ou Processus Ciliaires comme revetus d'une Pellicule Blanchâtre; et c'est peut-être, aussi, ce qui augmente l'épaisseur de la portion antérieure de la Capsule CrySTALLAINE." Yet, in p. 231. he describes the Black Paint of the Choroid Coat as connected with the Capsule of the Vitreous Humour, instead of the Retina: "Les Sillons Rayonnés de la Tunique Vitrée sont tout à fait Noirs."

HALLER, *Pr. Lin.* dxv.: "Ubi vero Retina ad Processus Ciliares pervenit, sequitur eorum ductum, et ad Lentem properat, in hujus Capsulam innata, et huic obducta, si fides et aliorum cl. Virorum et meis experimentis haberi potest: neque enim de eo sine in Quadrupedibus constat." But, in a later Work, he expresses his doubts of the accuracy of the above description: *El. Phys. Lib. xvi.* p. 388. "Omnibus perpensis, amplio, ei sententiæ propior quæ Membranulam a Retina diversam, inter Uveam et Vitream, ad Lentem producit."

Authors, as Drs HALLER and WINSLOW, I examined this matter with some care in the Human Eye; and it then appeared to me, that the Retina terminated abruptly about the Root of the Ciliary Processes, resembling the Brim of a Tea-Cup: And, as the opinion of WINSLOW, FERREIN, and, at that time, of Dr HALLER, that it was fixed to and covered the CrySTALLINE Lens, appeared to me incredible, because it would have been struck with the Light, before this was collected into a Focus or Picture; and as a Figure, published, some time thereafter, by the generally accurate ZINN*, seemed to correspond with what I had seen, I prosecuted the subject with less attention than perhaps I should otherwise have done.

Lately, I asked the favour of my very dexterous and accurate Assistant, Mr FYFE, to repeat the dissection of the Eye, in the Ox as well as in the Human Body, and to draw a Figure of the Termination of the Retina. His first Figure

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corresponded

* ZINN, Tab. ii. Fig. 1. and in Cap. iii. p. 116. lin. 13. "Ad Originem
"Processuum Ciliarium, non sensim evanescere, sed Fine ubique æquali et ac-
"curatè limitato terminari."

corresponded with what I had observed: But he told me, afterwards, That, on being still more cautious in his dissection, the Retina appeared to him to be continued on the Inner Side of the Ciliary Processes, and to terminate in the Outer Edge of the Crystalline Lens. On reviewing the subject, I observed, beyond all doubt, that this is the case; and likewise discovered the causes of the error into which I had fallen with Dr ZINN. In the first place, When the Continuation of the Choroid Coat and Ciliary Processes is lifted up, the Black Paint, which lines these, adheres to and conceals the Retina. In the next place, The Retina has so much support from the Paint on its Outer Side, and such a degree of Adhesion, first to the Capsule of the Vitreous Humour, and then to the Edge of the Lens, and has so little Connection to the Choroid Coat behind the Root of the Ciliary Processes, that, in the course of the dissection, a slight Pressure being made, the Retina is lacerated, and appears to terminate abruptly at the Root of the Ciliary Processes.

To shew the Termination of the Retina in the Outer Edge of the Crystalline Lens, let the Eye be laid on the Cornea, and a Circular Cut then made, through all the Coats of the Eye and Vitreous Humour, behind the Ciliary Circle; the

the Retina will then be seen, lining the Black Paint upon the Ciliary Processes, and passing from these to the Lens.

Next, let the Cornea and Sclerotic be taken off, the Iris cut away, and the Ciliary Processes raised off from the Paint which lines them and sticks to the Anterior Part of the Retina; and then, with a very soft Pencil, dipt in water, let the Black Paint be brushed off, and the whole Course of the Retina will be seen distinctly.

On examining the Retina with still greater accuracy, it appears, that it has exactly the same Number of Folds or Doublings that the Choroid Coat has; for it enters Double between the Ciliary Processes, nearly in the same way that the Pia Mater enters into the Furrows of the Brain. The Furrows and Doublings of the Retina, which, if we are to use the favourite term of *Ciliary*, may be called its Ciliary Processes, make an impression on the Anterior Part of the Vitreous Humour.

I have already observed, that the Black Paint lining the Ciliary Processes of the Choroid Coat, has a considerable adhesion to the Retina, which is Thinner here than on the Posterior Part of the Vitreous Humour; and, on its Inner
Side,

Side, the Retina adheres still more firmly to the Coat of the Vitreous Humour, which is much Tougher here than it is where it covers the Back Part of the Vitreous Humour. At last, the Extremities of its Ciliary Processes divide into a still greater Number of Parts or Fibres, resembling the small Branches of Nerves in other places of the Body, which are closely connected to the Fore Part of the Capsule of the Lens, about One-twentieth of an Inch distant from its Outer Edge, or Place where the Anterior and Posterior Plano-convex Lenses which form it, are joined together. After which, these Fibres either terminate, or become suddenly so pellucid, that it is impossible to trace them farther; and it is surely highly improbable that they form an External Coat to the Capsule of the Lens, as WINSLOW, FERREIN, and HALLER, supposed, or that their Continuation on it assists in Vision, as the Rays of Light are not so fully collected upon the Capsule of the Lens as to form a distinct Picture, and we farther observe, that when a Cataract is very opaque, the Light which falls on the Capsule of the Lens gives no distinct idea of objects.

The Retina, at its connection with the Vitreous Humour and Crystalline, is remarkably Tougher than it is in any other part; or it seems to adhere there, to the Anterior Layer of the

the

the Capsule of the Vitreous Humour, by Cellular Threads, or perhaps by the Pia Mater, which, as I have elsewhere endeavoured to prove, accompanies the Nerves in their whole progress.

In the several Figures of Table First, and Table First *, the Course and Termination of the Retina are accurately represented; and the Reader may now consult the Explanation given of these Tables.

In consequence of the Termination of the Retina being extended to the CrySTALLINE Lens, it is evident, that, in Couching, the Surgeon must, before he reaches the Lens, wound the Retina with his Needle; and if he afterwards depresses the Capsule along with the Body of the Lens, or if a Needle is passed around the Lens in order to detach it from the neighbouring parts, as has been advised †, the Anterior Edge of the Retina must be lacerated, and very much injured.

As:

† Mr. du WENZEL junior, on the Cataract, Sect. xvi.

As the Rays of Light cannot be directly collected, so as to form a distinct Picture on that part of the Retina which lines the Ciliary Circle and Ciliary Processes, there is perhaps reason to suspect, that the Light which is reflected from the Picture formed at the Bottom of the Eye, does not assist Vision, by giving a Second Stroke to that part of the Retina on which the distinct Picture is formed,—which seems to be the idea of Authors; for such a Second and Posterior Stroke would have nearly or exactly the same effect as the First: But rather, that we receive, on the Anterior Part of the Retina, lining the Ciliary Circle and Roots of the Ciliary Processes, a Second and very different kind of Impulse, by the Light reflected from the Bottom of the Eye to this part, by which we see and judge better of the object.

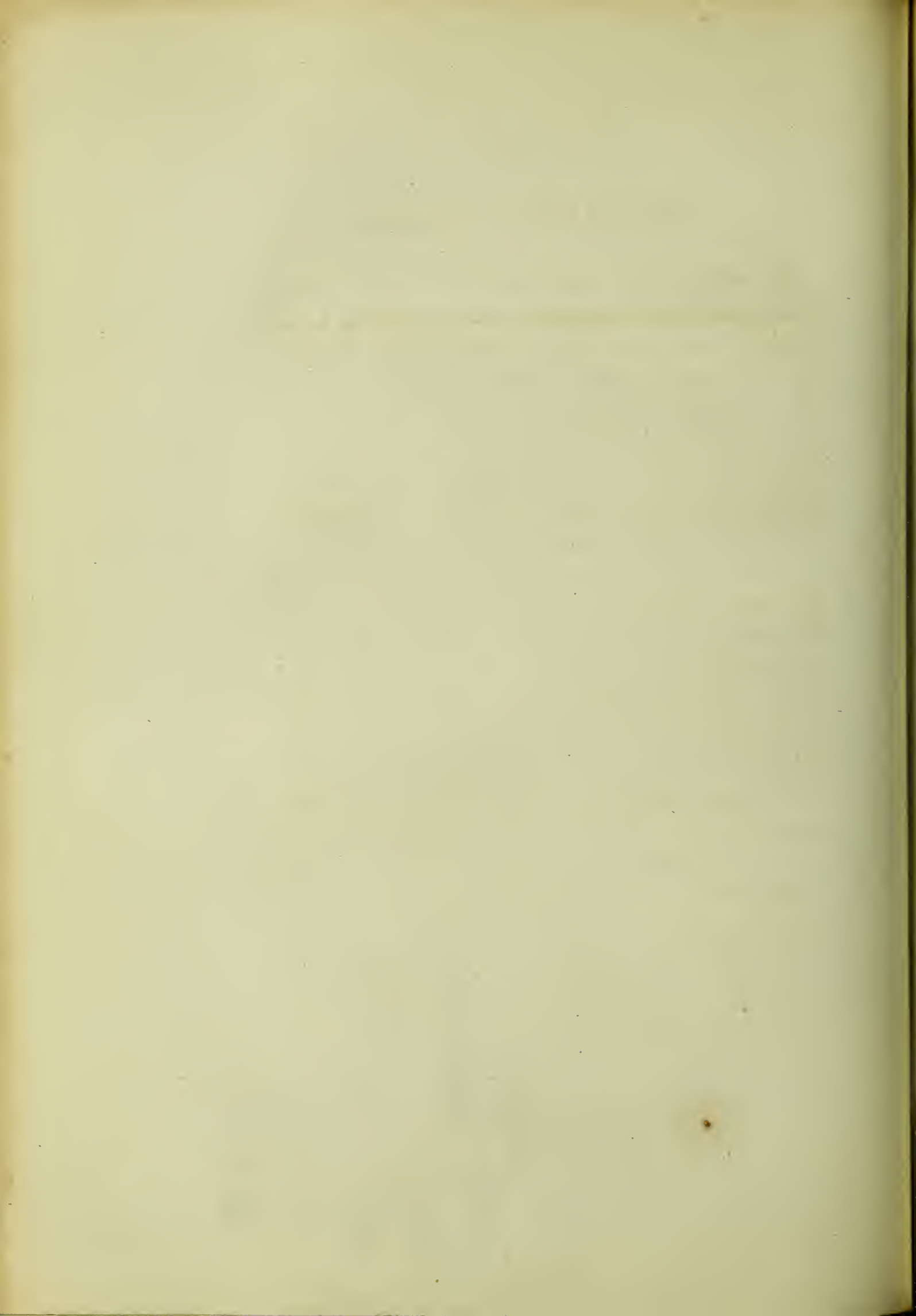
This supposition seems to be strongly supported by the general observation, that the Paint lining the Choroid Coat at the Bottom of the Eye, which has been called *Tapetum*, is remarkably Bright, and fit for the Reflection of Light in those Animals which seek their food in the Night-time, when such an aid is evidently most necessary.

The

The Analogy of the Cochlea of the Ear, which receives One Impulse through the Chain of Bones connected to the Membrane of the Oval Hole, and Another by the Membrane of the Foramen Rotundum, supports this Opinion.

N

C H A P.



C H A P. IV.

Of the Choroid Coat and Ciliary Processes.

IN Man, and, so far as I have observed, in all the *Genera* of the Mammalia, Birds, Amphibia, and Fishes, the Choroid Coat and Ciliary Processes consist of a Vascular Coat lined with Paint: But, in one *Species*, the White Rabbit, I have found, that the Paint is wanting *, and the same thing is true of their Iris; and hence their Eyes appear Red; because the Blood circulating in the Vascular Part of the Choroid, is seen through the Humours. It is probable, that in other *Species* or Varieties of Animals in which the Eyes appear very Red, a similar Defect of the Paint will be discovered.

* Book on Fishes, Chap. xii.

I have already observed, that the Colour of the Paint is Brightest, and most fit to reflect Light, in those Animals which seek their food in the Night-time: But, in all Animals which have the Paint, it is found to be Black where it lines the Ciliary Circle and Processes, or where it covers the Anterior Part and Termination of the Retina; in order, I suppose, to suffocate the Rays of Light which are reflected from the Bottom of the Eye upon this part of the Retina: And this seems likewise to confirm what I have alleged, that no advantage in Vision is to be derived from Light striking first the Inner-side, and then being reflected upon the Outer-side of the same part of the Retina.

When the Paint is carefully washed off from the Inner-side of the Choroid Coat, we see evidently, that the Ciliary Processes are formed by the Continuation of the Choroid Coat, folded seventy or eighty times, so as to occupy a smaller Circle.

The Ciliary Circle, and Roots of the Ciliary Processes, are firmly glued to the Anterior Part of the Retina, almost as far as to its Termination, or Insertion in the Outer Edge of the Lens: But the Points or Terminations of the Ciliary Processes float loose in the Posterior Chamber of the Aqueous Humour,

Humour, and have no direct Connexion with the Lens. ZINN, who observed that the Terminations of the Ciliary Processes were not connected with the Lens*, concluded therefore, that the Inner Parts of the Ciliary Processes were inserted into the Capsule of the Vitreous Humour†: But I have already observed, that the Anterior Part of the Retina reaches to the Edge of the Lens, or intervenes between the Ciliary Processes and Vitreous Humour.

It appears therefore, That the Ciliary Processes do not form a complete Septum between the Aqueous and Vitreous Humours; and, That the Capsule of the Crystalline Lens is not supported in its place by the Terminations of the Ciliary Processes of the Choroid Coat in it; but that it owes its Support to the intimate Union of its Posterior Part with the Posterior Layer of the Capsule of the Vitreous Humour, and

to

* See ZINN, Chap. ii. p. 66. "*Ipfa tamen illa extrema libera, ad Lentem non solum pertingant, sed etiam ultra ejus Circulum maximum progressa, &c. sine pendulo libero, &c. terminantur.*"

† ZINN, Chap. ii. p. 78. "*Vitreo arctissimè sunt juncti.*"

to the Infertion of the Anterior Layer of the Capſule of the Vitreous Humour and Retina into it, near to its Circumference.

Whilst the Retina, by the Toughneſs of its Pia Mater, gives more additional Support to the Lens than we might be apt to ſuppoſe from its general Tenderneſs; it is itſelf ſupported in its place, beſides ſerving the uſe before mentioned, of receiving Impreſſions by the Light reflected from the Bottom of the Eye.

In the ſeveral Figures of Table Firſt, and Table Firſt *, theſe Parts are delineated; and to the Explanation of them I ſhall refer the Reader.

CHAP. V.

Of the Iris.

S E C T. I.

IN the Book I published on Fishes *, I stated the several circumstances which prove, beyond doubt, that the Vessels of the Iris are not Colourless, as RUYSCH, VIEUSSENS, FERREIN, Dr HALLER, ZINN, and others, following them †, have taught ;

* Chap. xi.

† RUYSCH, Ep. xiii. — VIEUSSENS, Tr. de Lin. p. 211. — FERREIN, Mem. de l'Acad. (1739). — HALLER, El. Phys. Lib. xvi. Sect. ii. § xxxiii. p. 435. " Ex
" eo porro Circulo numerosa Vascula in Uveam veniunt, in variis Animalibus,
" et

taught ; but that, on the contrary, they are Large, Red, Numerous, and circulate an extraordinary quantity of Red Blood.

Since that time, I have observed, in one case, a White Speck on the Iris, produced by Inflammation, on the Surface of which I could see distinctly Vessels filled with Red Blood.

In three other cases, I have observed a very remarkable appearance, which, so far as I know, has escaped the observation of Oculists.

In two of these cases, where the Eyes had been long inflamed, a Network of Filaments passed from one side of the Iris, across the Pupil, to the other side of it, covered with Paint of the same colour with that of the Iris.

In

" et imprimis in Piscibus, Sanguine plena, in Homine pellucida."—ZINN de Oculo, Cap. ii. p. 92. Not. f. " Ut inde elici posse videatur in Homine vivo, Vascula " liquorem sanguine tenuiorem et decolorem vehere."

In the third case, of a Person who had had a White Cataract in one of his Eyes for upwards of Twenty Years, a Network of Vessels, covered with Paint darker than that of the Iris, was extended from the Iris upon the Surface of the Cataract.

I pointed out these appearances, in one of the cases, to Mr ANDERSON, Surgeon in Leith, and, in another, to Mr LAW, Surgeon in Edinburgh, who were attending the Patients along with me.

S E C T. II.

THE Nerves of the Iris are so numerous, that, proportioned to its Weight, no part of the Human Body is perhaps so plentifully supplied with them.

 S E C T. III.

BUT, what account are we to give of its Muscular Fibres; or of those Fibres by means of which its motions are performed?

When we look into the Works of Dr HALLER, we find this celebrated Author, after quoting the accounts given by others, affirming, in the most pointed manner, That, although he examined the Iris of the Ox with the Microscope, he could not perceive in it any Circular Fibres: And his Pupil and Successor (Dr WRISBERG) affirms the same*.

Confiding

* HALLER. El. Phys. Lib. xvi. Sect. 11. p. 371. "Ex hypothese, plurimi
 " Scriptores Fibras esse, in circulum circumductas. Verum eas sæpe, et myopibus
 " meis, cætera bonis, oculis, et lentibus vitreis, vehementer augmentibus, adjutis
 " cum quærerem, nunquam reperi ullas."—p. 378. "Circulus in Uvea constrictor
 " nullus est."—HALLER. Pr. Lin. Phys. § dxii. "Orbiculares Fibras, con-
 " centricas

Confiding in the accuracy of Dr HALLER, I, for many years, examined this organ with less attention than, probably, I should otherwise have done. But having, at last, examined carefully the Iris of an Ox, after washing off the Paint, I was not more pleased than surpris'd, to find, on its Anterior Part, a broad flat oval Organ, with Fibres of a dark reddish Colour, dispos'd in nearly the same manner as those of the Orbicularis Palpebrarum are.

Its appearance is, in all respects, so evidently Muscular, that I think there can be no doubt of its being the Sphincter of the Pupil : And I can only account for its having esca-

O 2

ped

“ centricas Pupillæ, neque Oculus, neque Microscopium, ne in Bove quidem, mihi
“ demonstravit.”

In a translation of Notes by Dr WRISBERG on HALLER's Primæ Lineæ, the Doctor writes as follows : “ Besides anatomical proofs, by which it is undoubtedly certain, that the Iris has no real Muscular Fibres, and that the contraction and dilatation of the Pupil is rather to be ascribed to the Vessels than to Muscles.”

ZINN de Oculo, Cap. ii. Sect. iii. § iv. p. 91. “ Dubius certe hæreo, annon
“ Fabrica Musculosa in Iride agnoscenda esse videtur.”

ped the observation of Dr HALLER and Dr WRISBERG, by supposing, that they had not washed off the Black Paint, which covers and conceals it, as well as the Red Vessels of the Iris.

On the Inner and Anterior Part of the Iris, and on the whole of its Posterior Part, the Fibres are disposed like Radii; and, if they are Muscular, they are well situated for dilating the Pupil. But these have many more Blood-vessels in their composition, and have much less the appearance of Muscular Fibres, than the oval fibrous Organ I have described on the Forepart of the Iris.

In Table II. Fig. 1. and 2. these Parts are elegantly and accurately represented, from Drawings made of them, at my request, by Mr FYFE.

My success in the Ox naturally prompted me to examine the Human Iris with greater attention than I had formerly bestowed on it; and in this I found, with equal satisfaction, a very distinct Sphincter Muscle; but somewhat differently disposed; for in Man it occupies the Innermost Part of the Iris, or forms a Ring immediately surrounding the Pupil, which is equally well seen on its Fore and Back Parts, and
makes

makes about One-Fifth Part of the Breadth of the Iris. Between the Sphincter and Root of the Iris, the Space is filled up with Vessels and Radiated Fibres.

See Table III. and its Explanation.

Dr ZINN, Dr HALLER, and Dr WRISBERG*, particularly the two latter, have doubted of, or denied, the Muscular, or, as they speak, Irritable nature of the Iris; because the Contraction of the Pupil is not occasioned by Strong Light falling upon it.

But.

* ZINN de Oculo, Cap. ii. Sect. iii. § iv. p. 95.

HALLER. El. Phys. Lib. xvi. Sect. ii. p. 371. "Nam, per experimenta sollicitè capta, Iris in vivo animale Irritabilitate omni destituitur, ipfisq; a lucis radiis, per conum chartaceam in solam Iridem determinatis, non movetur; sed Musculo proprium est, esse irritabilem."

WRISBERG, in a Note on HALLER, Pr. Lin. Phys. § DXIII. "My own experiments have convinced me, that the Iris does not belong to the parts endowed with regular Irritability; for the solar light directed upon the Iris remains without any such effect."

But their inference is by no means to be admitted.

Because, without alleging that its being roused into action by the irritation of the Retina, is scarcely to be explained, but on the supposition that the Living Principle is first excited, and a Muscular Action in consequence produced; I would observe, that the Colour or Paint upon the Iris, which prevents the Light from getting to the Bottom of the Eye except through the Pupil, must, like a Cuticula, prevent the Light from irritating the Iris, unless we suppose it to be concentrated in a very great degree.

In the next place, we are to consider, that, in the common offices of life, Light is collected into a Focus, or so concentrated, that it may prove hurtful to the Retina alone; and therefore Nature has, in general, regulated the action of the Iris, according to the Quantity of the Light which falls upon the Retina.

I would further observe, that various other Muscles are thrown into a more sudden and violent action, by Stimuli applied to distant organs, than if the same Stimuli had been directly applied to those Muscles. Thus, if a Drop of Cold Water, or even a Drop of Warm Saliva, falls into the Glottis,

tis, the very distant Abdominal Muscles are suddenly convulsed. I surely need not say, that the Warm Saliva, directly applied to those Muscles, laid bare by dissection, would produce no such effect.

In the last place, I have, many years ago, observed in the Parrot, that the Pupil is, alternately, greatly contracted and dilated, whilst the Eye is exposed to the same degree of faint Light *; which is quite inconsistent with the idea, that the action of the Iris is produced by the sole and direct effect of Stimuli applied to it.

C H A P.

* See Dr PORTERFIELD's Book on the Eyes, Vol. ii. Chap. v. p. 151.

CHAP. VI.

Of the Vessels of the Cornea.

SECT. I.

IN the Book which I published on the Structure and Physiology of Fishes, in the year 1785, I observed, (Ch. XI.) that the Vessels containing Red Blood, which are seen upon the Cornea after an Inflammation of it, are not its original Vessels dilated, but are newly-formed Vessels, rooted in the Tunica Adnata, and extended, from it, over the External Surface of the Cornea ; and hence, that Surgeons might perceive the propriety of attempting to remove these, and the Specks produced by them, by Chirurgical means and External applications.

P

I would

I would now observe, that, in every case I have examined since that time, I have found a confirmation of the truth of the above assertion.



S E C T. II.

It may be worth while to add, that, on examining an Opake Circle, which, in many very old Persons, encroaches upon the Cornea, I have found that Circle full of very minute Vessels, rooted likewise in the Adnata, and extended on the External Surface of the Cornea, without entering between its Layers.

C H A P.

CHAP. VII.

Of certain Laws by which we judge of the Position and Distance of Objects, and by which we regulate the Motions of the Eyes.

SECT. I.

ALTHOUGH the whole Picture of an Object formed on the Bottom of the Eye be inverted, we form a just judgment of the Position of its Parts ; because we are taught by Instinct, that each Pencil of Rays which strikes the Retina must have come from the opposite side. Just as, when our Hand is held supine in the horizontal posture, if the

Back of it be struck, we suppose the stroke to have come from Below ; and, if the Palm, from Above.

I apprehend we are further taught by Instinct, that the Light has passed through the Pupil, and that we therefore form a more correct idea of the Position of the Object, than when, with Authors *, we imagine, that the Light is traced perpendicularly from the Place of the Picture.

S E C T. II.

As we derive many advantages from directing the Axes of the Two Eyes to the same point, the supposition made by Authors, that this Direction is not given by Instinct, but
proceeds

* Dr PORTERFIELD and Dr REID.—See Dr REID's Inquiry into the Human Mind, On Seeing, Chap. vi. Sect. xii. p. 261. " A visible object appears in the " direction of a right line, perpendicular to the retina at that point where its " image is painted."

proceeds from Custom and Habit *, must, at first sight, appear extremely improbable ; and the more I have attended to the Motions of the Eyes, not only in Infants, but in other very young Animals, the more I am convinced that the Uniform Motion of the Eyes, and the accurate Direction of Both to One Point, is Original.

We may observe many other Complex Actions, Respiration, Sucking, Deglutition, performed without Experience : ' Why then doubt that the Uniform Motion of the Eyes is regulated by a similar Law ?

That, by Habit, we are less able to move the Eyes in different Directions in the advanced than in the early period of life, is at the same time true.

S E C T.

* Dr PORTERFIELD on the Eye, Vol. I. Book ii. Chap. v. p. 23. " The true cause of this uniform motion depends on Custom and Habit."

Dr REID, p. 240. " Nature hath very wisely left us the power of varying the parallelism of our Eyes a little, so that we can direct them to the same point, whether remote or near. This no doubt is learned by Custom."

S E C T. III.

THE Direction of the Optic Axes furnishes, no doubt, an auxiliary means by which we judge of the Distances of Objects ; but strange oversights have been committed by Authors on this subject, and particularly by Dr PORTERFIELD, who supposes effects to proceed solely from this cause, which evidently flow from others.

Thus, he tells us, that when a Person has had the misfortune of losing one of his Eyes, or even if a Person shuts one of his Eyes, he cannot readily fill out a dish of tea, or snuff a candle, because he wants the concurrence of the Optic Axes ; without considering, that the degree of action or straining of the Muscles necessary to direct the Axis of One Eye to the object, would have nearly the same effect on the Mind as the Direction of Both Axes to the same point. Besides, he forgets, that the Axis of the Eye which is shut, and even that of the blind Eye, for a long time at least, follows the motion of the other.

In

In like manner, in his principal experiment by which he proves that the Eyes accommodate themselves to the Distances of Objects, he observes, that if we shut the Left Eye, and, with the Right Eye, view a Luminous Point through two small Holes in a Card, this Point will appear Single at a certain distance to which the Eye is accommodated, but will appear Double in all other situations; because the Rays of Light which pass through small Holes, form such distinct Pictures, that the Eye is not solicited to alter its Conformation to the Distance. And he proves that the above is a just account, by next observing, that if the Left Eye is opened, and Both Eyes directed to the Luminous Point, the Double appearance of it instantly vanishes. But, in attempting to explain the Causes which prompt the Mind to act, he supposes, that the Two Optic Axes being now directed to the same Point, we are enabled to take the Angle, and so measure the Distance; not reflecting, that the Axis of the Left Eye, whilst it was Shut, was guided by the Direction of the Open Eye, or had had the same Direction when it was Shut, as when it was Opened.

Hence Dr PORTERFIELD, though he proves, by this experiment, that the Eye alters its Conformation, has not pointed
ed

ed out the true Means by which it judges of the Distance, and is therefore solicited to act.

These, I apprehend, in this case, depend on the clearer view which the Two Eyes receive, not only of the Luminous Point, but of the relative Situation of the several Objects which are nearer to or farther from us than it; by means of which the Mind judges more accurately of the Distance, and therefore accommodates the Eye to it.

C H A P.

C H A P. VIII.

Of the Means by which we accommodate the Eye to the Distances of Objects.

THAT the Human Eye possesses the power of accommodating itself to the Distances of Objects, seems beyond a doubt *: And, I think, I can prove, that this power is not restricted within the narrow limit of Twenty-seven Inches, as Dr PORTERFIELD contends; for I find, that when I place two minute Objects in nearly the same line, the nearest of them at the distance of Three Feet, and the other at double or treble that distance, on viewing them alternately with one Eye, they become alternately confused and distinct.

Q

But

* See Dr PORTERFIELD on the Eyes.

But, to ascertain the Means by which the Eye accommodates itself to the Distances of Objects, is a matter of much difficulty.

The following are the chief Means enumerated ; on each of which I shall make a few Remarks. And I shall then point out an Additional Means, which has escaped the observation of Authors.



S E C T. I.

It has been supposed, that the Fibres which enter into the composition of the CrySTALLINE Lens are Muscular, and that, by their Contraction, they render the Lens more Convex, and therefore adapt the Eye to near Objects. But to this opinion I have, in the First Chapter of this Paper, proposed Objections, to which I shall refer the Reader.

S E C T.

S E C T. II.

THE Ciliary Processes have been supposed to be chief agents. But, without stating, that Muscular Fibres are not to be seen in these Processes*, or the improbability that the Choroid Coat, of which they are the Continuation, in the form of Folds or Doublings, is Muscular, as its general action would be useless and even injurious to the Retina; and without repeating the argument, that the Eye seems to accommodate itself after the Extraction of the Lens;—I would remind the Reader, that their Extremities float loose in the Aqueous Humour, and that their Inner-part is connected to the Lens by the medium of the Retina: Nor is their direction such, that they can be supposed capable of pulling the Lens forwards, by pulling the Retina: Or, if we were to suppose them to be Muscular, and to act with considerable force, they would render the Lens flatter, by pulling its

Q 2

Circular

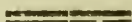
* ZINN, Cap. ii. p. 70. "Neque unquam Microscopio unicam Fibræ Muscularæ reperiri potui."

Circular Edge outwards, and would therefore have the effect, contrary to what is supposed, of rendering the Eye less fit for viewing near objects.



S E C T. III.

THE Iris, by lessening the Pupil, and cutting off the most diverging rays of light, when we are viewing near objects, unquestionably makes the Picture on the Retina more distinct, and therefore renders the Object more distinct.



S E C T. IV.

SOME, as JURIN, have thought, that the Iris might, by its Contraction, have the effect of drawing the Root of the Cornea inwards; and, by this means, render the Cornea more Convex: And the Disposition of the Sphincter Muscle of the Iris, especially in the Ox, may seem to support this opinion.

But

But I must observe, That the Iris is not Rooted in the Cornea, as those who maintain this opinion suppose, but in the Sclerotic Coat, which in Man is thicker and resists more than the Cornea, and in many other Animals is remarkably hard and inflexible. Besides this, I have shewn, that, in Man, the Sphincter Muscle of the Iris is placed on the Inner Edge of the Iris, with the interposition of the Radiated Vascular Substance between it and the Sclerotic; so that it cannot directly affect the Sclerotic and Cornea.

To these we may add, that, in a clear light, when the Iris is strongly contracted, we see remote objects distinctly: Whereas, if the strong contraction of the Iris which then takes place, rendered the Cornea more Convex, and thereby fitted the Eye for near objects, those should appear confused.

S E C T. V.

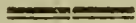
THE External Muscles, and particularly the Recti, have, by many, been thought to be well adapted for elongating the Axis of the Eye; and a late Writer alleges, that the
Recti.

Recti terminate partly in the External Layer of the Cornea, and therefore are better suited, than was imagined, for such a purpose. But here I would observe, in the first place, That, on re-examining this point of Anatomy with attention, I have found all the Tendinous Fibres of the Recti firmly attached to the Sclerotic, at the distance of a quarter of an inch from the Edge of the Cornea, and no appearance that any part of them, or that any Membrane produced by them, is continued over the Cornea*.

In

* By experiment on the Human Eye, I found, that the Weight of Fifty-four Ounces tore one of the Recti Muscles; but that it required the Weight of a Hundred Ounces to tear its Tendon from the Sclerotic Coat, and when the Tendon quitted the Sclerotic, there was no appearance seen of its Fibres passing forwards over the Cornea. And, the generally very accurate, ZINN, who had no particular Theory to support or to refute, expresses himself on this subject in the following words: "Tendines illorum Musculorum singuli, etsi ad insertionem latiores evadunt, distincti tamen semper manent, et, ubi immixtis in Scleroticam Fibris, illi tam intimè jam affiguntur, ut sine manifesta laceratione ulterius dividi non possint, satis magno inter se distant intervallo, nec alibi sese contingunt, ut, nunquam in unum jungi, aut propriam tunicam continuam constituere posse, affirmari possit." ZINN de Oculo, Cap. i. p. 14.

In the next place, if they had terminated partly in the External Layer of the Cornea, in such a manner as to affect it chiefly, they should, by pulling the whole External Layer of the Cornea backwards, have flattened the Cornea, instead of rendering it more convex.



S E C T. VI.

ABOUT fifteen years ago, it occurred to me, that, although we should grant, to Dr PORTERFIELD and others, that the Axis of the Eye could not be elongated by the Recti Muscles ; yet, that the Oblique Muscles, which are thrown, in opposite directions, around the Eyeball, might have this effect. I have since observed, that Dr KEIL, HAMBERGERUS, and other Physiologists, had long ago entertained the same idea *.

To

* Dr KEIL, Ang. Chap. iv. Sect. iv. " The Aqueous Humour, being the
 " thinnest and most liquid, easily changes its figure, when either the Ligamentum
 " Ciliare.

To be better understood, I had a Preparation and Drawing made of the Oblique Muscles ; from which Table III. was engraved.



S E C T. VII.

I SHALL conclude, by pointing out one other Means, that had not occurred to Authors, which we employ when we view minute objects placed near to the Eyes.

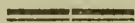
If we attend to what passes in that case, we may be sensible that we bring the Upper and Under Eyelids nearer to each other ; and then, by a considerable exertion, contract the parts about the Eyes.

On

“ Ciliare contracts, or both the Oblique Muscles squeeze the middle of the Bulb of the Eye, to render it oblong, when objects are too near us.” — BRIGGS et HAMBERGER. de Oculo, p. 180. propose the same opinion.

On confidering this, it appeared to me probable, that the Orbicular Mufcle of the Eyelids might, by its preffure on the Upper and Under Parts of the Cornea, make thefe somewhat Flatter, and, of courfe, protrude the Middle Part of the Cornea between the Edges of the Eyelids, fo as to render it more Convex; at the fame time increafing its diftance from the Lens, and lengthening the Axis of the Eye-ball.

On putting this matter to the teft of the following Experiments, the event appeared to correpond exactly with the idea I had formed.



EXPERIMENT I.

IN a clofet, lighted by a fingle window, I fat on a chair, with my back to the window, and fixed a Book, with Small Print, on the oppofite wall. I then brought my Eyes fo near to the Book, that the Letters became indiftinct. I then made an Exertion to read, without contracting the Orbicularis; or, I opened the Eyelids wide, by acting with the Attollens Palpebram Superiorem; or, I held the Upper

R

and

and Under Eyelids with my fingers at a distance from each other, and then repeated my effort to read the Book ; but found I could not do it. That is, my Eyes were so near to the Book, that, although I attempted to exert all the means before enumerated, the Eyes were not so much altered in their conformation as to render the vision distinct. In this Experiment, no part of the Cornea was covered by the Eyelids, for the Eyelids were at the distance of Half an Inch from each other.



EXPERIMENT II.

IN this Experiment, I kept my head in the same posture, and at the same distance from the Book, as in the former Experiment ; but I acted with the Orbicularis Palpebrarum, so as to bring the Edges of the Eyelids within a Quarter of an Inch of each other, and then made an exertion to read, and found I could see the Letters and Words distinctly.

EX-

EXPERIMENT III.

IN this Experiment, I kept my head in the same posture, and at the same distance from the Book, as in the two former Experiments ; but, instead of employing the Muscular Contraction of the Orbicularis Palpebrarum, I brought the Edges of the Upper and Under Eyelids within a Quarter of an Inch of each other, by means of my fingers, and then stretched the Edges of the Eyelids so as to make Pressure on the Upper and Under Edges of the Cornea ; and found that the Letters then appeared distinct.

As, in all these Experiments, the Distance of the Eye from the Object, and the Quantity of Light, were the same ; as no Part of the Pupil was covered by the Eyelids, so as to cut off the most diverging Rays ; as the Object appeared confused when the Orbicularis was not contracted ; and distinct on its contracting ; — there can be no doubt that

the Action of the Orbicularis helps to accommodate the Eye for seeing near Objects more distinctly *.

S E C T.

* On the 1st day of May 1794, Dr DAVID HOSACK read to the Royal Society of London, Observations on Vision, in which (Phil. Transf. 1794, Part. II. xv. p. 222.) he writes as follows: "With a Speculum, I made pressure on the Eye, while directing attention to an Object twenty yards distant, and saw it distinctly: but, endeavouring to look beyond it, every thing appeared confused.

"I then increased the Pressure considerably, in consequence of which I was enabled to see objects distinctly at a much nearer than the natural focal distance; for example, I held a Book before my Eye at the distance of two inches. In the natural state of the Eye, I could neither distinguish Lines nor Letters: but, on making Pressure with the Speculum, I was enabled to distinguish both Lines and Letters of the Book with ease."

I find myself, therefore, under the disagreeable necessity of adding, That I mentioned the above Experiments, in my Public Course of Lectures, on the 27th day of April 1789:—That I have repeated the mention of them in every Course of my Lectures since that time:—That Dr WHEATON BRADISH, in his Inaugural Dissertation "De Visu," published on September 12. 1792, and which I did not read till it was published, mentions, in p. 39. these opinions, which I had proposed in my Lectures, in the following words: "Longè verò ante alias enitescit sententia, quæ interni auxilio cujusvis spreto, Musculos quosdam Oculi externos, obliquos nempe, insuper et Orbicularem, hos simul præstare effectus asseruit. Tali modo
" Oculi

S E C T. VIII.

Upon the whole : it appears to me,

1. That the Iris, by lessening the Pupil, and intercepting the most diverging Rays of Light, renders the Picture of near Objects more distinct.

2. That the Recti Muscles, by their action, lengthen the Axis, because they press chiefly on the Sides of the Eyeball; and, further, the Cornea is not only more dilatable than the Sclerotic in general is, but it will be found that the Sclerotic, in Man and other Animals, is thinner and more dilatable, in its Anterior Part, and in its Posterior Part where the Picture is formed, than it is on its Sides.

3. That

" Oculi Axin augeri, Corneamque convexam magis quam antea reddi."—That Dr DAVID HOSACK attended my Course of Lectures the winter after Dr BRADISH published his Inaugural Dissertation, to wit, 1792-3, which was finished upwards of a year before Dr HOSACK read his Paper to the Royal Society.

3. That the two Oblique Muscles forming an Oblique Girth around the Eyeball, between the Lens and Bottom of the Eye, must, by their Pressure, increase the Distance of the Lens from the Retina, or increase the Length of the Posterior Part of the Axis of the Eyeball.

4. The Orbicularis Palpebrarum renders the Fore and Middle Part of the Cornea, opposite to the Pupil, more Convex; and increases the Length of the Anterior Part of the Axis of the Eyeball. And it is evident that all these Means may concur in forming perfect Vision.

C H A P.

CHAP. IX.

Of the Lachrymal Ducts.

SECT. I.

VERY eminent Authors, HALLER and ZINN, having started their doubts of the Existence of Ducts from the Glandula Innominata of GALEN*, I was led to examine the subject

* HALLER, in Pr. Lin. Phys. Cap. xviii. § 498. "Lachrymam partim arteriæ conjunctivæ tunicae exhalant, partim creditur deponere Glandula," &c.
"In Homine nondum satis certo, neque mihi unquam visi sunt Ductus."

T. G. ZINN,

subject with accuracy ; and, after finding one large Duct from it in Birds, I discovered a number of small Ducts from it in the Human Body, running nearly parallel with each other, and terminating on the Inner-side of the Upper Eyelid, not far from the External Canthus of the Eye.

After introducing Bristles into some of them, I injected Quicksilver into a few others ; and I still preserve the Preparations I made then, and have demonstrated them, since that time, annually in my Public Courses of Lectures. In 1758, I published a Description of them *, illustrated by the Figures reprinted in Table IV. of this Paper.

S E C T.

T. G. ZINN, de Oculo, Cap. xiii. § 1. " Lachrymas maxima certè ex parte
" exhalare videtur arteriæ conjunctivæ," &c. " In Homine autem huc usque
" accuratissimorum Anatomicorum aciem Ductus illi effugerunt : neque mihi, hac
" in re, illis feliciorum esse contigit."

* Observations Anatomical and Physiological, 1758, 8vo.

S E C T. II.

SINCE that time, finding that the error had been committed, by the greater number of Anatomists and Surgeons, of supposing, that the Two Ducts which lead from the Puncta are united before they enter the Lachrymal Sac; and thinking, that, in certain cases, it might be material in the cure, that the Surgeon knew that one of these Ducts might be pervious, though the other was obstructed; I had an accurate Drawing of them, and of the Lachrymal Sac, and Nafal Duct, made, which the Reader will find in Table V. Fig. 1. And, in Fig. 2. and 3. of the same Table, the appearance of the Termination of the Nafal Duct is delineated.

S E C T. III.

To trace fully the course of the Tears, Two other Canals, I apprehend, remain to be described; I mean the Ductus Incisivi. In Quadrupeds, as in the Ox and Sheep, these are

S

Two

Two Large Canals, open at both ends, and passing obliquely downwards from the Nose into the Mouth, represented in Tables VI. and VII.

In by far the greater number of Human Subjects, of different ages, I have not been able to find any vestige of such Ducts, in the Bottom of the Nose, or Roof of the Mouth: But, in a few subjects, I have found them, open at both ends, but always very much smaller than in the Quadruped. In some of these, I passed a Bristle or Small Probe, very readily, from the Nose into the Mouth. In two or three subjects, I first poured Quicksilver from the Nose, through the Ductus Incisivus, into the Mouth; and then, with a small Syringe, injected through it Melted Wax, coloured with Vermilion: And these Preparations, which I have preserved and demonstrated for a great number of years, are accurately delineated in Table V. Fig. 4, 5, 6, 7.



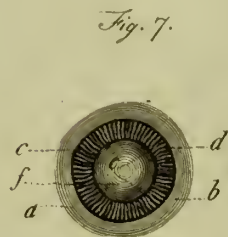
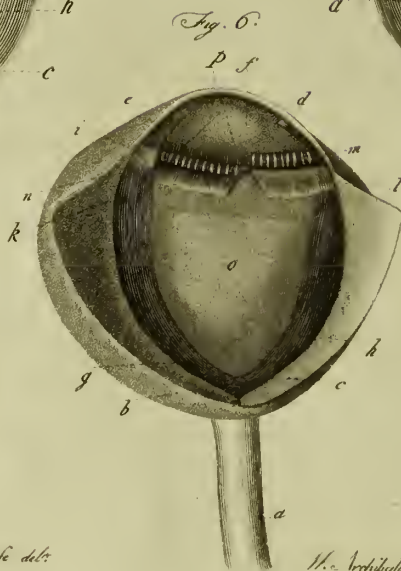
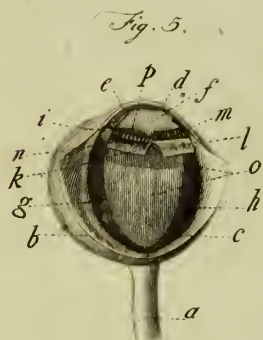
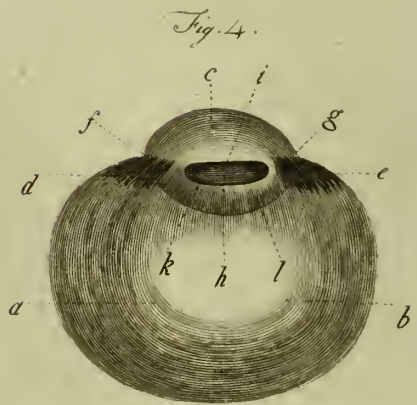
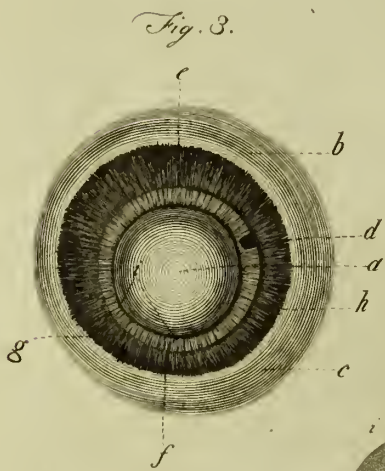
S E C T. IV.

IN Man, and in the Quadruped, the Lachrymal Ducts are always directed towards the Forepart of the Nose, and terminate

minate over the Ductus Incisivi; and the Ductus Incisivi begin from Cups or Funnels, which form the Lowermost Parts of the Bottom of the Nostrils: So that, beyond all doubt, the Tears are applied to and pass through them into the mouth; and it seems by no means improbable, that the Ductus Incisivi, like the Puncta Lachrymalia and Ducts through which the Tears are conveyed into the Nose, may be excited into action by that kind of Irritation which the Tears give. Why they are always found, and large, in the Quadruped; yet generally wanting, and always small, in Man; cannot, without farther observation, be satisfactorily explained.



TAB. I.



A. Syffe del.

W. Verhulst sculp.

EXPLANATION
OF THE
T A B L E S.

Explanation of Table I.

THE First Four Figures of this Table represent the Eye of an Ox dissected. The Fifth, Sixth, and Seventh Figures represent the Human Eye.

FIG.

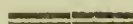
F I G. 1.

Represents the Left Eye of an Ox, viewed obliquely from above.

- a* The Trunk of the Optic Nerve.
- b c* The Outer Part of the Sclerotic Coat.
- d e* The Cut Edge of the Sclerotic Coat.
- f g* A Section of the Root of the Cornea.
- h* The Crystalline Lens, seen at the Pupil, inclosed in its Capsule.
- i* The Inner Radiated Part of the Iris.
- k* The Sphincter Muscle of the Iris.
- l m* The Outer-side of the Choroid Coat.

n The

- n* The Ciliary Circle, joining the Choroid Coat to the Root of the Iris, and Both these Coats to the Sclerotic Coat.
- o* A Portion of the Iris inverted, after cutting it.
- p* The Ciliary Processes of the Choroid Coat, the Extremities of which float in the Posterior Chamber of the Aqueous Humour, or between the Back-part of the Iris and the Crystalline Lens.
- q* The Retina issuing from the Optic Nerve.
- r* The Middle Part of the Retina.
- f* The Choroid Coat, lined with its Black Paint, between the Ciliary Circle and the Continuation of the Retina forwards.



In F I G. 2.

The same Eye is represented more fully dissected.

a Represents the Trunk of the Optic Nerve.

b c The Sclerotic Coat cut and turned aside.

d e A Section of the Cornea near its Root.

f The Under Half of the Iris.

g The CrySTALLINE Lens inclosed in its Capsule.

h i The Outer-side of the Choroid Coat.

k l The Ciliary Circle.

m The Ciliary Processes, with their Extremities floating in the Aqueous Humour between the Iris and the Lens.

n A

- n* A Portion of the Iris inverted.
- o* The Extremities of a Number of the Ciliary Processes inverted, to shew how far they are loose.
- p* The Middle Part of the Retina.
- q* The Doublings or Ciliary Processes of the Retina, from which the Black Paint, lining the Ciliary Processes of the Choroid Coat, is washed off.
- r* The Ciliary Processes of the Retina divided into Minute Fibres, which are inserted into the Anterior Part of the Capsule of the CrySTALLINE Lens.

In F I G. 3.

After removing the Cornea, the Iris, the Choroid Coat with its Paint, and inflating the Canal discovered by Dr PETIT, a Fore View is given of the Cryftalline Lens, with the Termination of the Retina, by Doublings or Ciliary Processes, in the Forepart of the Capsule of the Lens, a very little within its Outer Edge.

a Represents the Forepart of the Cryftalline inclosed in its Capsule.

b c The Vitreous Humour covered by the Retinal

d A Hole cut in the Forepart of the Canal of PETIT, by which it was inflated.

e f The Circular Canal of PETIT inflated, to shew that it is not Cylindrical, but Cellular, somewhat resembling the Colon.

g b The

- g b* The Doublings or Ciliary Processes of the Retina, adhering to the Anterior Layer of the Capsule of the Vitreous Humour, and, with that, forming the Forepart of the Canal of PETIT.
- i* The Minute Terminations of the Ciliary Processes of the Retina, in the Anterior Part of the Capsule of the Lens, very near to the Outer Edge of the Lens.



F I G. 4.

In this Figure, a Side View is given of the CrySTALLINE Lens and Vitreous Humour adhering together, and their Capsules entire.

a b The Vitreous Humour inclosed in its Capsule.

c The Forepart of the CrySTALLINE Lens.

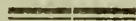
T 2

d e The

- d e* The Roots of the Ciliary Processes of the Retina, with some of the Black Paint of the Choroid Coat adhering to their Outer Side, and the Anterior Layer of the Capsule of the Vitreous Humour lining them.
- f g* The Insertion of the Retina, with the Anterior Layer of the Vitreous Humour, in the Forepart of the Capsule of the Lens.
- b* An Oblong Hole cut in the Outer Part of the Canal of PETIT, through which the Outer Edge of the Lens is seen, covered with its proper Capsule, forming the Inner-side of the Canal of PETIT.
- i* The Anterior, and *k* the Posterior, Layer of the Capsule of the Vitreous Humour, fixed to the Capsule of the Lens at a considerable distance from each other. Hence it appears, that the Forepart of the Canal of PETIT is formed by the Anterior Layer of the Vitreous Humour, covered by the Retina; the Posterior Part of it, by the Vitreous Humour, covered by the Posterior Layer of its Capsule;

Capsule ; and that the Inner-side of it, is formed by the Edge of the Cryftalline, covered by its proper Capsule only, where its greatest Diameter is found, or where the Two Lenses which compose it are conjoined.

- l* The Backpart of the Cryftalline Lens seen through the Vitreous Humour.



F I G. 5. & 6.

In these Figures, the Connexion of the Coats of the Human Eye is represented. In Fig. 5. the Parts are represented of their Natural Size : In Fig. 6. they are magnified to Two Diameters.

a The Optic Nerve.

b c The Sclerotic Coat, cut and turned aside.

d The Cut Edge of the Cornea.

e The

- e* The Iris.
- f* The Forepart of the Lens.
- g b* The Outer Sides of the Choroid Coat.
- i* The Ciliary Circle.
- k l* The Iris cut and turned backwards.
- m* The Ciliary Processes of the Choroid Coat in their natural situation, with their Extremities floating loose in the Aqueous Humour, and covering the Outer Edge of the Lens.
- n* The Extremities of the Ciliary Processes turned back, to shew how much of them is loose, or unconnected with the Parts on the Inner-side of them.
- o* The Middle Part of the Retina.
- q* The Anterior Part of the Retina, connected to the Capsule of the Lens by the Fibrous Extremities of its Ciliary Processes.

FIG.

FIG. 7.

This Figure represents the Retina lining the Posterior Part of the Ciliary Processes, and inserted into the Capsule of the Lens.

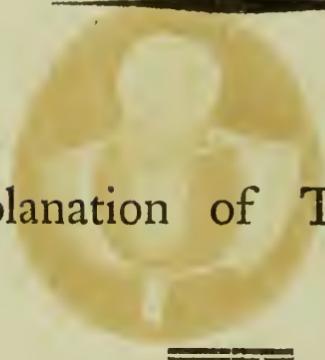
a b The Inner-side of a Part of the Sclerotic Coat.

c d The Ciliary Processes of the Retina, on the Inner-side of the Paint which lines the Ciliary Processes of the Choroid Coat.

f The Posterior Part of the Crystalline Lens inclosed in its Capsule.

e The Fibrous Extremities of the Ciliary Processes of the Retina, in their course, over the Edge of the Crystalline Lens, to their Terminations in the Forepart of its Capsule.

Explanation



Explanation of Table I.*

F I G. I.

Represents the Human Eye dissected.

a The Optic Nerve.

b b The Sclerotic Coat, cut and turned outwards.

c The Sclerotic Coat, cut and turned forwards with the Cornea *d*.

e e One-half of the Iris in its place.

f The

TAB. I. *.

Fig. 1.



Fig. 2.



A. Syffr. del.

H. Ambrato sc.



- f* The Pupil and Cryſtalline Lens in its place.
- g g* The Ciliary Circle.
- h h* The Choroid Coat.
- h* The Ciliary Proceſſes ſeen in their places, by cutting off a portion of the Iris.
- i* A Portion of the Iris cut and turned back.
- k* The Floating Points of the Ciliary Proceſſes turned backwards.
- l* The Middle Smooth Part of the Retina, ſeen by cutting a Hole in the Choroid Coat.
- m* The Roots of the Ciliary Proceſſes of the Retina, to which the Black Paint of the Ciliary Proceſſes of the Choroid Coat adheres.
- n* The Ciliary Proceſſes of the Retina, inſerted into the Capſule of the Cryſtalline Lens.

U

FIG.

F I G. 2.

Represents, chiefly, the Circle of PETIT in the Human Eye.

- a a* The Vitreous Humour inclosed in its Capsule.
- b* The Cryftalline Lens inclosed in its Capsule.
- c* The Ciliary Proceſſes of the Retina inserted into the
 Capsule of the Cryftalline Lens.
- d* The Circular Canal of PETIT inflated.
- e* A Hole cut in the Circular Canal of PETIT, at which
 the Air diſtending it was blown in.

Explanation

TAB. II.

Fig. 1.

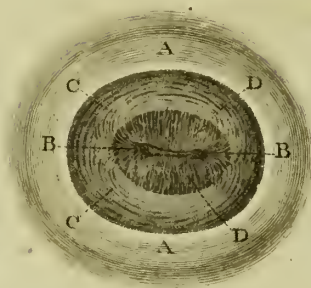
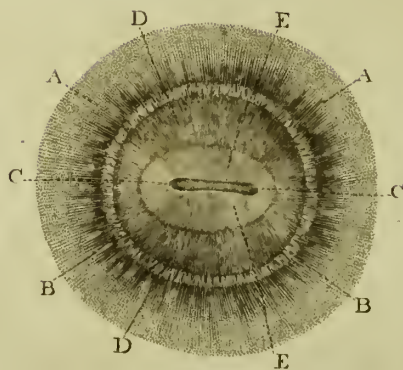


Fig. 2.



Al. Aspe. del.

H. m. Aspe.

Explanation of Table II.

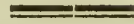
FIG. 1. represents the Forepart, and Fig. 2. the Backpart, of the Iris of an Ox, of its Natural Size.

In F I G. 1.

- A A Represents the Cut Edge of the Sclerotic Coat.
- B B The Pupil.
- C C The Sphincter Muscle of the Iris.
- D D The Inner Part of the Iris, in which the Fibres are radiated, without any appearance of a Sphincter Muscle.

U 2

In

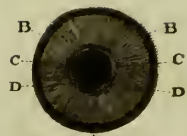


In F I G. 2.

- A A Represents the Inner-side of the Anterior Part of the Choroid Coat.
- B B The Ciliary Processes.
- C C The Pupil.
- D D The Outer and Back Part of the Iris, which consists of Vascular and Radiated Fibres that conceal the Sphincter Muscle.
- E E The Inner and Back Part of the Iris, composed, like its Forepart, of Radiated and Vascular Fibres.

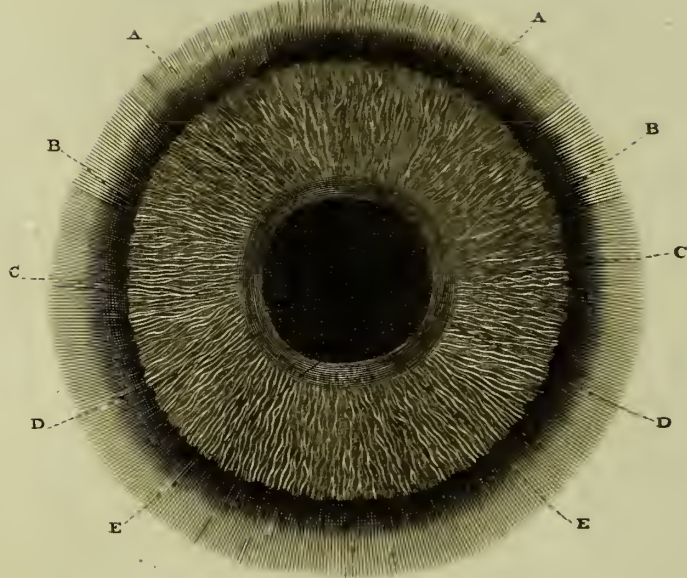
Explanation

Fig. 1.



TAB. III.

Fig. 2.



*N. Lysse del.
H. Archbold sc.*

Explanation of Table III.

THE Two Figures in this Table represent the Posterior Part of the Human Iris, delineated by Mr FYFE. Fig. 1. shews it of the Natural Size, and Fig. 2. represents it Magnified.

A A The Inner-side of the Anterior Part of the Choroid Coat.

B B The Ciliary Processes.

C C The Vessels and Radiated Fibres.

D D The Muscular Sphincter of the Iris.

E The Pupil.

Explanation

Explanation of Table IV.

THIS Table represents the Right Eye with its Muscles, viewed obliquely from its Upper and Outer Side.

- a* Represents the Eyeball.
- b* Part of the Upper Eyelid.
- c* The Optic Nerve.
- d* The Attollens Palpebram Superiorem drawn aside by a Pin.
- e* The Rectus Attollens Oculum.
- f* The Rectus Abductor Oculi.

g The

TAB. IV.





- g* The Rectus Adductor Oculi.
- h* The Rectus Deprimens Oculum.
- i* The Flefhy Belly of the Obliquus Superior Trochlearis.
- k* The Trochlea, fixed to the Os Frontis, with the Tendon passing through it.
- l* The Infertion of the Tendon of the Trochlearis in the Eyeball.
- m* The Inferior Oblique Mufcle taking its rife from the Superior Maxillary Bone.
- n* The Infertion of the Tendon of the Inferior Oblique Mufcle in the Eyeball.

Explanation

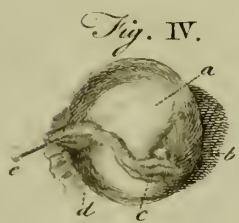
Explanation of Table V.

F I G. 1.

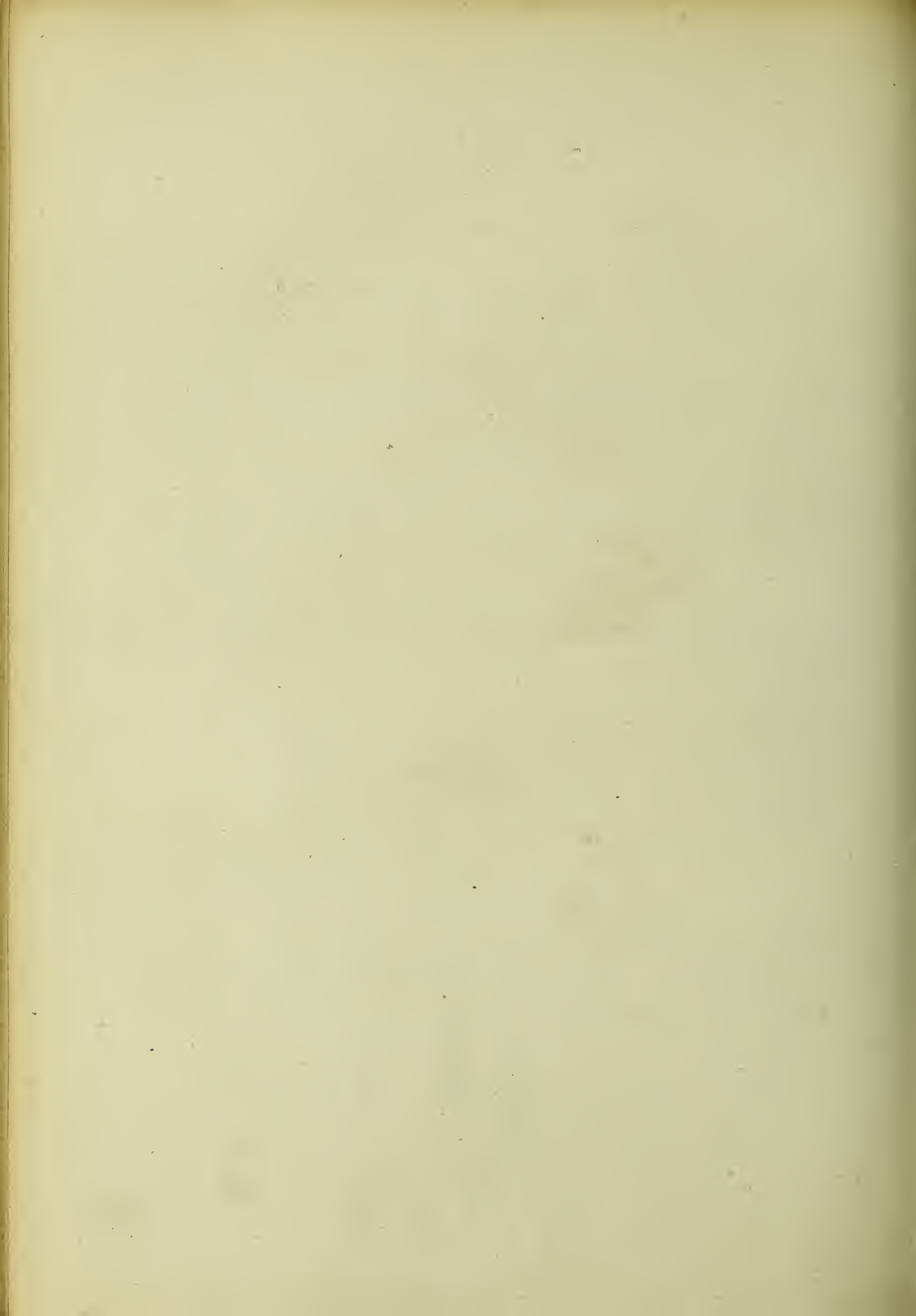
Represents the Upper Eyelid of the Right Side of the Human Subject, with the Glandula Innominata GALENI, or Lachrymal Gland.

- a* The Inner-side of the Upper Eyelid.
- p* The Two Puncta Lachrymalia, into which the different Ends of a Bit of Wire are introduced.
- b* Part of the Under Eyelid.
- c* The External Canthus.
- d* The Thicker Conglomerated Part of the Lachrymal Gland.

TAB.V.
Fig. I.



A. Bell. Sculp.



- e* A Number of Smaller Lachrymal Glands, lying between *d* and the Conjunctiva, which, for distinction's sake, I shall call Glandulæ Lachrymales Congregatæ.
- f* Four Bristles introduced into the Ducts of the Lachrymal Gland.
- g* One of these Ducts, into which Quicksilver was injected, which is hid where it passes between the Glandulæ Congregatæ *e*, but appears again, where it comes out of the Glandula Innominata, composed of Three Branches.
- h* A Part of the Tunica Conjunctiva, at which, before the Preparation was immersed in Spirits, the Orifices of two or three very small Lachrymal Ducts could be perceived.



F I G. 2.

Represents the like Parts on the Left Side, viewed from the Upper and Outer Side.

a The Outer Side of the Tunica Conjunctiva of the Left Eye.

b c d d e e The same as in Fig. 1.

f The Artery of the Lachrymal Gland injected.

g The End of a Bristle put into one of the Lachrymal Ducts *b*, after I had injected the Duct with Quick-silver.

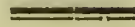
i i Two Branches joining to compose the Duct *b*.

F I G.

F I G. 3.

Represents the Right Eye of the Common Hen.

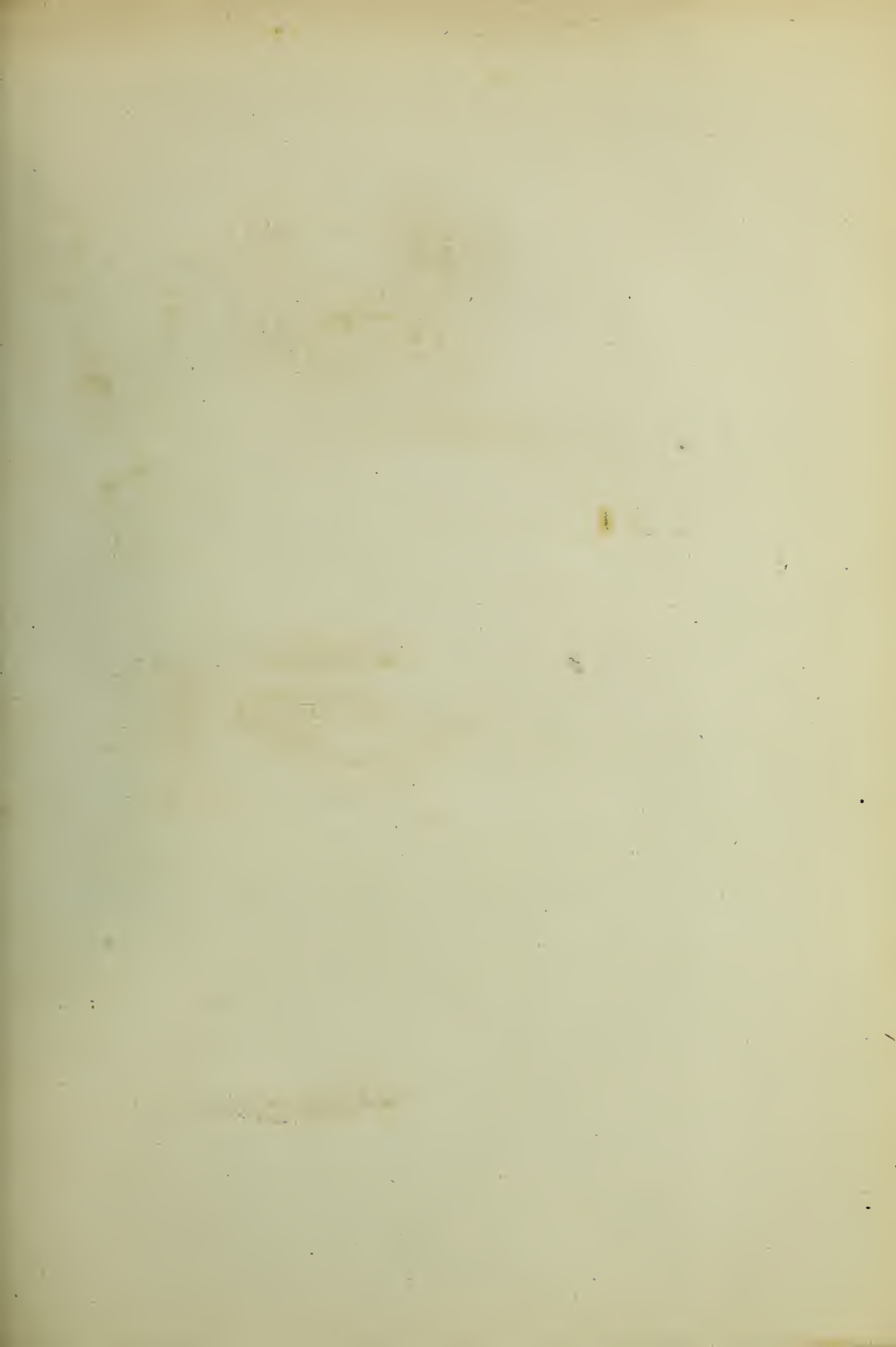
- a* An Outline of the Comb and Beak.
- b* The Eyeball.
- c* The Eyelids.
- d* The Membrana Nictitans.
- e* A Probe passed into the Duct of the Lachrymal Gland.
- f* A Probe passed into the Undermost Punctum Lachrymale.
- g* A Probe passed from the Uppermost Punctum Lachrymale into the Nose, and from the Nose into the Mouth.



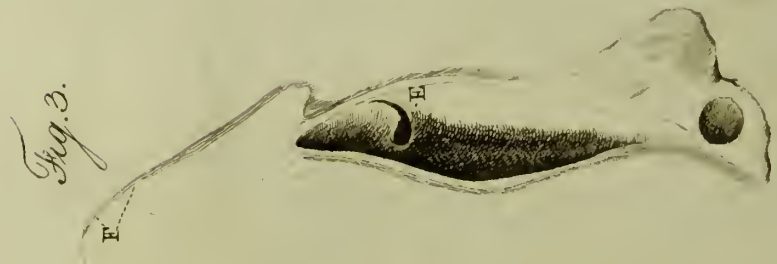
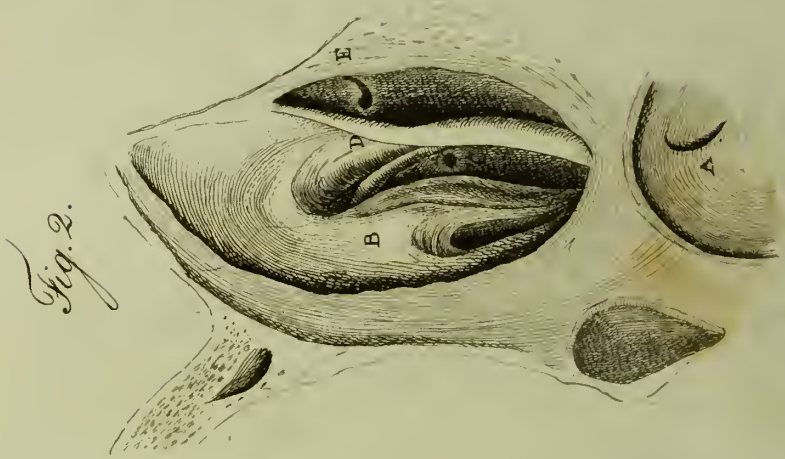
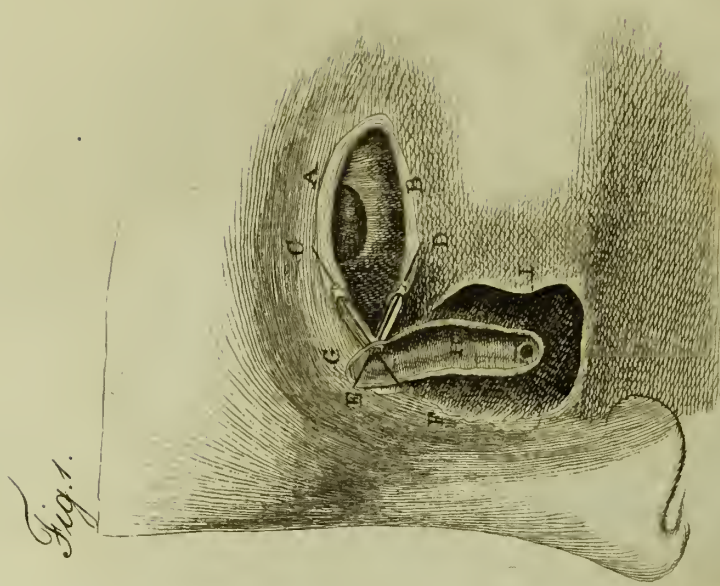
In F I G. 4.

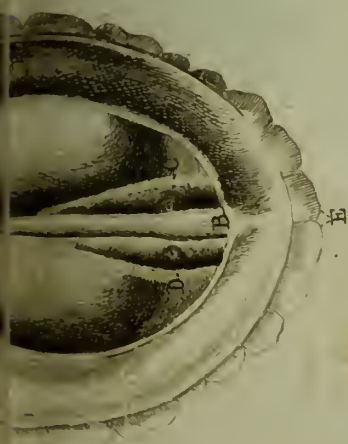
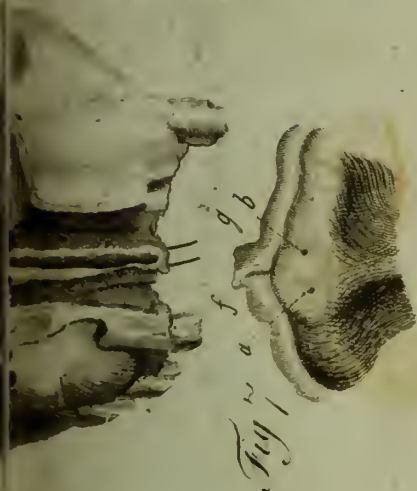
- a* Represents the Bottom of the Eyeball in the same Fowl.
- b* The Optic Nerve.
- c* The Lachrymal Gland.
- d* Part of the Membrana Nictitans.
- e* A Probe passed into the Lachrymal Duct.

Explanation



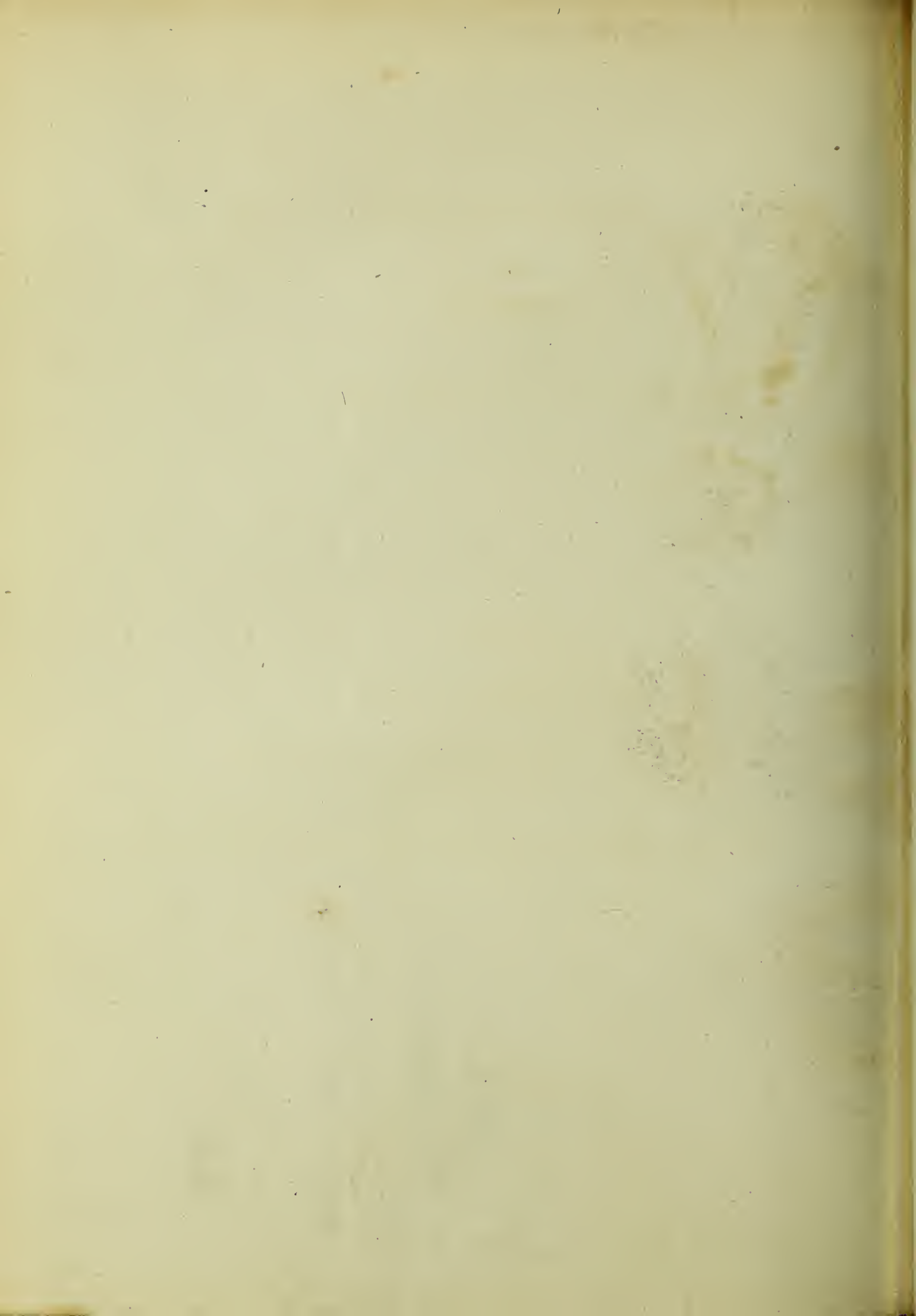
TAB. VI.





A. Fyfe del.

G. Cameron sculp.



Explanation of Table VI.

In FIG. 1.

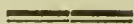
- A Represents the Upper and B the Under Eyelid.

- C D Bristles introduced into the Two Puncta Lachrymalia, and the Ducts from them cut open.

- E F The Termination of these Ducts in the Lachrymal Sac, by two distinct Orifices.

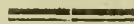
- G H I The Lachrymal Sac and Nasal Duct laid open.

In



In F I G. 2. & 3.

The Termination of the Nasal Lachrymal Duct in the Nose is seen at E E, under the Os Spongiosum Inferius D.



F I G. 4.

ABBC Represents Part of the Septum Narium.

D The Mouth of the Left Eustachian Tube.

E The Superior, and F the Inferior, Os Spongiosum of the Left Side.

H I K The Ductus Incisivus of the Right Side laid open, after passing a Bristle through it.

F I G.

F I G. 5.

A B Represents the Septum Narium cut horizontally.

C D The Upper Orifices of the Ductus Incisivi.

E The Dentes Incisivi.

F I G. 6.

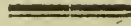
By cutting off the Foreparts of the Upper Jaw-Bones, the Ductus Incisivi are seen, with Probes passed through them from the Bottom of the Nose into the Mouth.

A The Bottom of the Septum Narium cut horizontally.

B C The Bottom of the Cavity of the Nose.

de & fg Bristles passed through the Ductus Incisivi.

F I G.



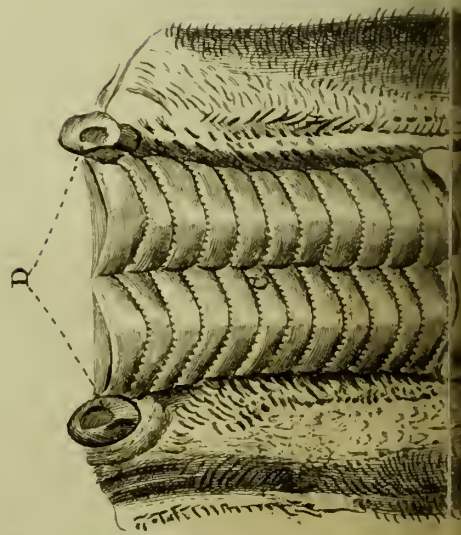
F I G. 7.

In this Figure, the Openings of the Ductus Incisivi into the Mouth are represented, from a Person, very far advanced in life, who had lost all the Teeth of both Jaws.

a b The Lower Orifices of the Ductus Incisivi.

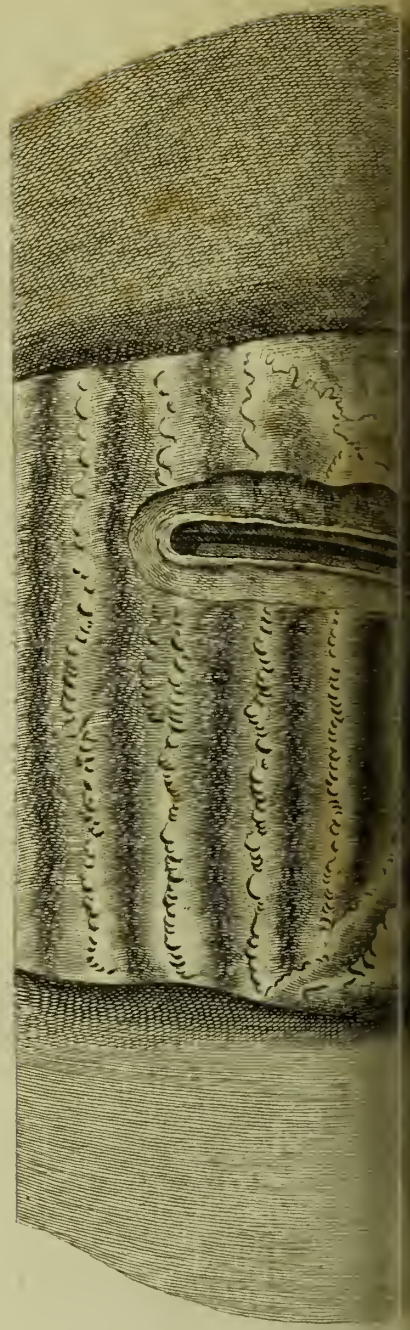
Explanation

Fig. 2.



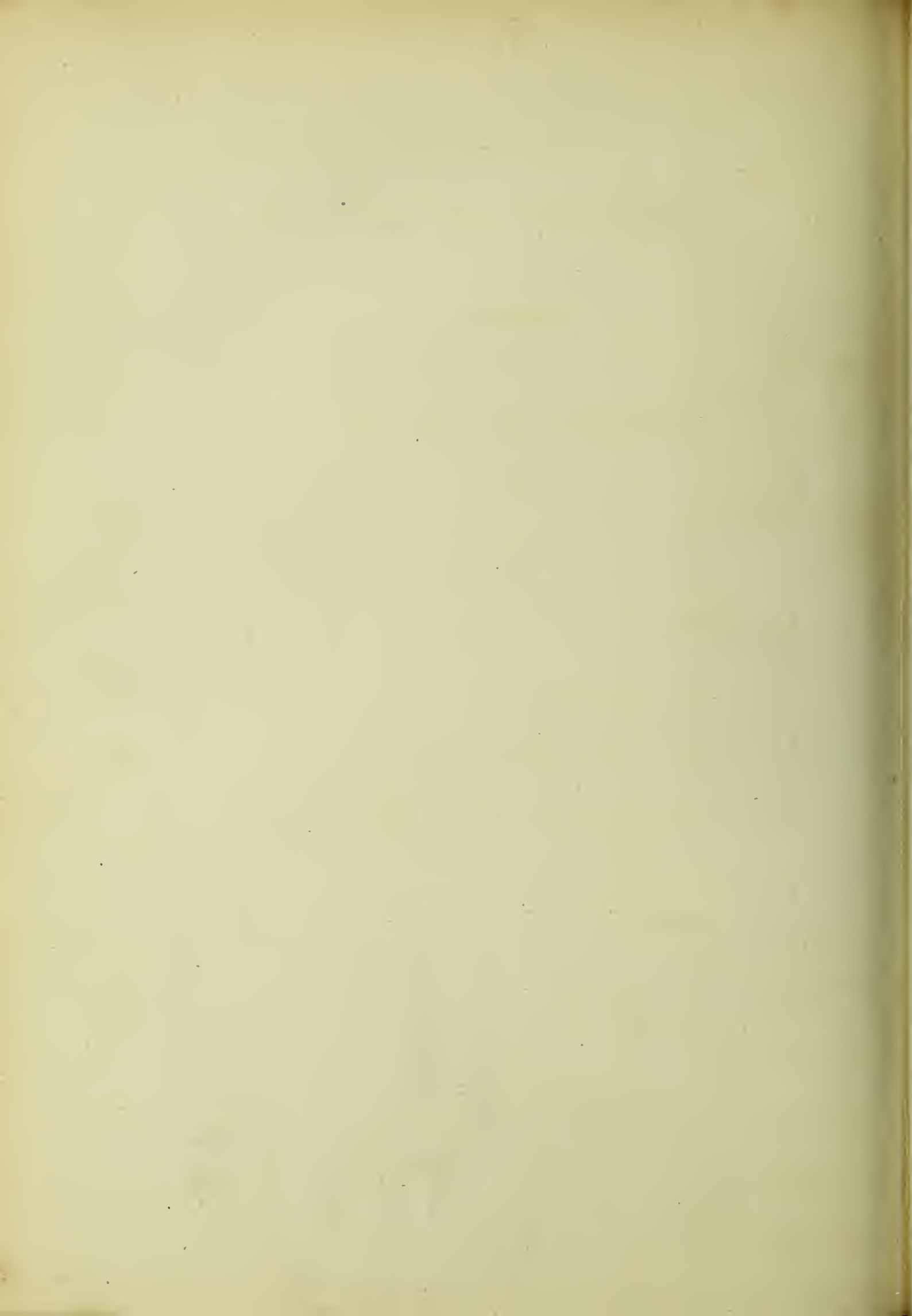
TAB. VII.

Fig. 1.



G. Cameron sculp.





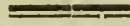
Explanation of Table VII.

F I G. 1.

- A Represents the Upper-Lip of the Ox.
- B The Callous Gum.
- C The Roof of the Mouth.
- E E The Natural Openings of the Two Ductus Incisivi.
- F The Under Part of the Right Ductus Incisivus cut open its whole length.

Y

In



In F I G. 2.

- A Represents the Upper Lip of the Sheep.
- B The Callous Gum.
- C The Roof of the Mouth.
- E The Natural Termination of the Left Ductus Incisivus.
- F A Probe passed from the Nose, through the Right Ductus Incisivus, into the Mouth.

Explanation

TAB. VIII



Explanation of Table VIII.

IN this Table, the Right Lachrymal Nafal Duēt of a Sheep is traced to its Termination in the Nose; which, when the Face of the Animal is placed horizontally, will be found to be over the Bottom of the Nose, a very little behind the Upper End of the Duētus Incisivus.

a Represents the Os Nafi of the Right Side cut.

b The Os Spongiosum Inferius.

c The Eyelids.

d e Probes passed through the Puncta Lachrymalia into the Lachrymal Sac.

f g The

- f g* The Lachrymal Nafal Duët laid open.
- b i* A Probe passed from the Lachrymal Duët into the
 Cavity of the Nose.
- k l* A Probe passed through the Canalis Incisivus.
- m* The Fiffure in the Upper Lip.

THE END OF TREATISE SECOND.

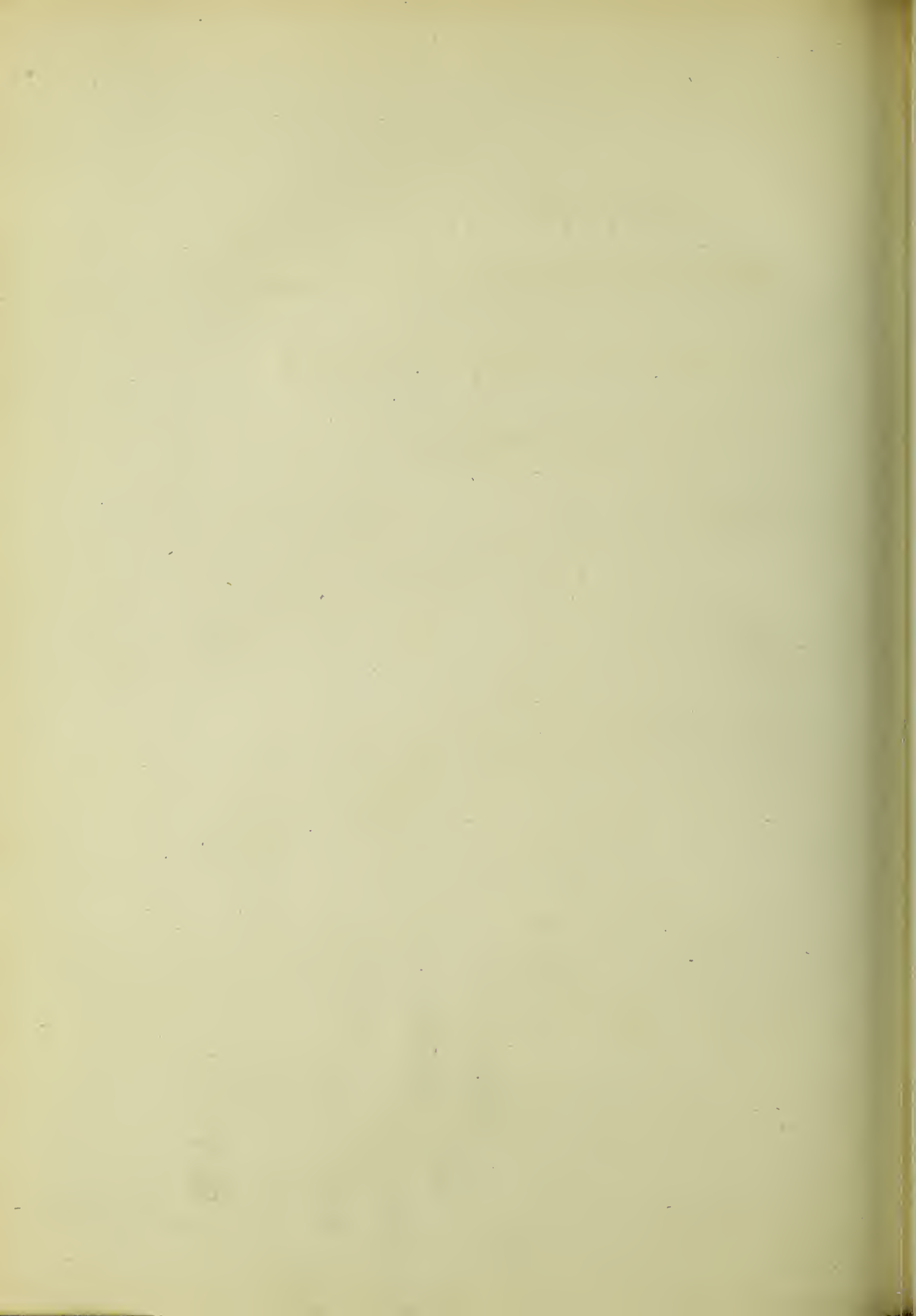
OBSERVATIONS
ON THE
ORGAN OF HEARING
IN
MAN
AND OTHER ANIMALS.

BY
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IN THE UNIVERSITY OF EDINBURGH.

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1797.



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PREFACE.

P R E F A C E.

SO far back as the year 1756, whilst I was in Berlin, observing, that no Anatomist had traced the Distribution of the Portio Mollis of the Auditory Nerve within the Cochlea, Vestible, and Semicircular Canals; or, that the Structure of those principal parts of the Ear on which ultimately Impression is made, and to which all the other pieces of its complex and elegant machinery are subservient, was unknown; I began to investigate the subject with accuracy, and soon found the means of tracing the progress of the Portio Mollis, the minute branches of which I prosecuted upon the Cochlea chiefly.

A a

From

From that time downwards, I have demonstrated these annually, in my Courses of Lectures in this University ; and, in 1783, when I published my Observations on the Nervous System, I gave a Description of these Preparations, illustrated by Figures, (See Tables XXIX. XXX. & XXXI.) ; and, before publication, I shewed my Preparations to several excellent judges.

Two years thereafter, in 1785, in a Work I published on the Structure and Physiology of Fishes, compared with those of Man and other Animals ; I described the Parts of the Ear in the Whale, in Amphibious Animals, and in Fishes ; and illustrated my Descriptions with a Number of Figures. (See Tables VII. XXXIV. XXXV. XXXVI. XXXVII. XXXVIII. & XXXIX.)

Soon thereafter, to-wit in 1787, I received a Letter from the late Dr CAMPER, in which he denies the existence of Semicircular Canals in Whales, and calls in question that of the Meatus Auditorius Externus in the Skate and Squalus Squatina, which I had described.

I should

I should not have pointed out to the Public what I knew to be erroneous in Dr CAMPER's Letter, if he had not, at the same time, written me, that he intended to have his Remarks inserted into a German Translation of my Book on Fishes, which he told me was then about to be published by Dr SCHNEIDER, "in order to put me right, and to be useful to others *."

Still later, in 1787, Dr ANTONIUS SCARPA, Professor of Anatomy and Surgery in Pavia, Ticinum, in a large Work, entitled, "*Disquisitiones Anatomicae de Auditu et Olfactu*," illustrated with many Tables, has represented the Description I had given of the Human Ear as inaccurate; and the whole of my Account of the Meatus Auditorius Externus, and of the Communication of it with the Interior Parts of the Ear, and of these with each other, in the Cartilaginous Fishes, as a mere fiction.

A a 2

Although

* I observe this Translation, by J. G. SCHNEIDER, with Dr CAMPER's Notes, quoted by Dr SOEMMERING as published, in 1787, at Leipzig; but I have not yet seen it.

Although, from the attention I had paid to these subjects, and that I had in my possession the several Preparations from which my Descriptions were taken, and had demonstrated these publicly in my Courses of Lectures, and privately to many good judges of such matters; yet, the reputation which Dr CAMPER and Dr SCARPA have acquired, made it necessary for me, on my own account, and likewise to prevent others from being misled, by their authority, on these highly curious and interesting parts of Anatomy, to resume my researches on these subjects.

The Public will reap the advantage of having these organs more fully described, and of seeing them more elegantly delineated, than in my former Figures, by my assistant Mr FYFE, from recent Preparations, which, at my request, he undertook to make; and which he has, by my direction, executed with great dexterity and accuracy.

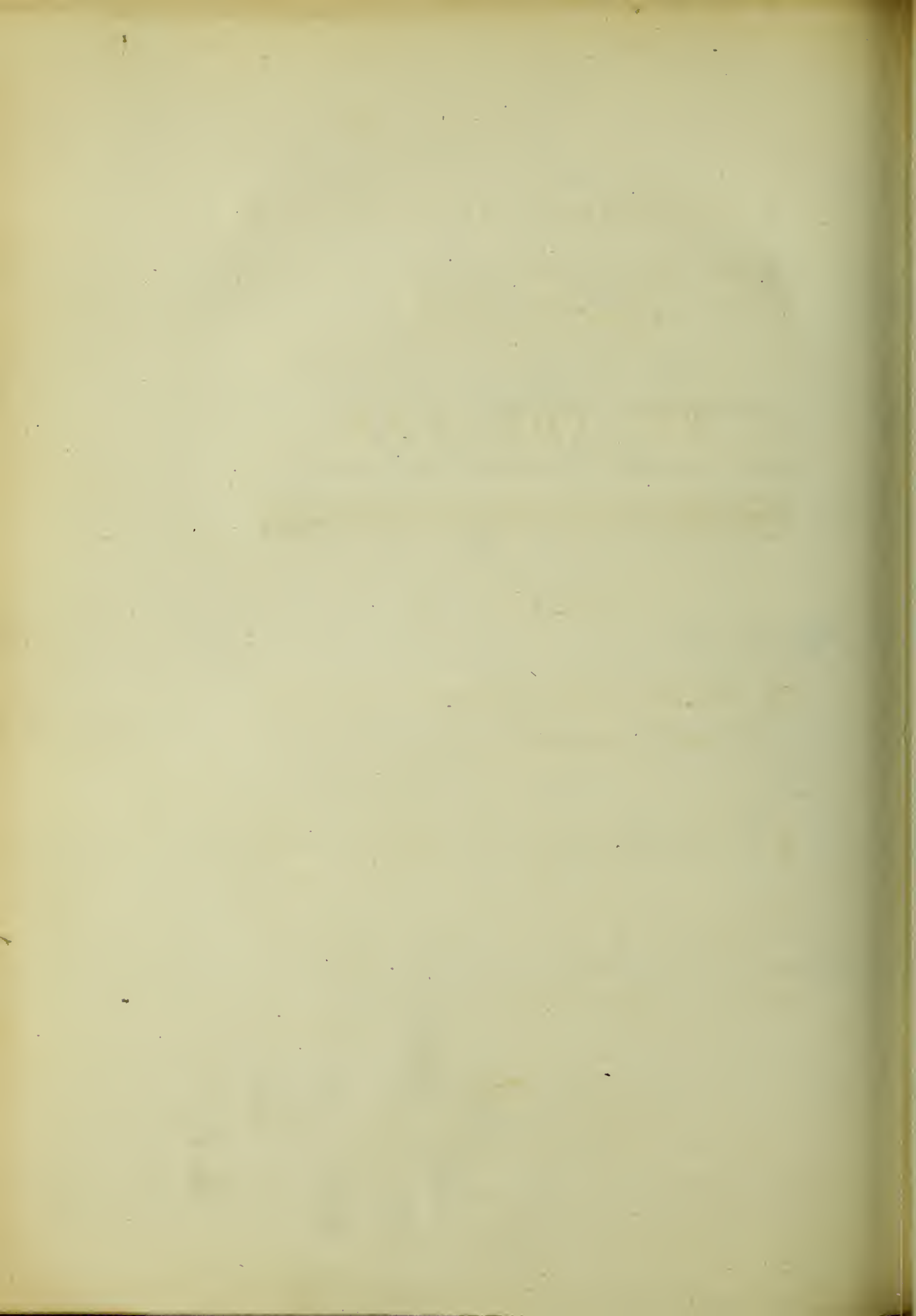
All the Preparations from which the Figures I formerly published, or which I now publish, have been taken, are still in my possession. They have all been lately demonstrated to the Members of the Royal Society of this place, and minutely examined by such Members as are best qualified to judge of such subjects, after they were made acquainted with

the

the doubts raised by CAMPER and SCARPA, and that their attestation as to facts would be requested.

I shall now proceed to describe the Structure of some of the principal Parts of the Ear, in Man and in other Animals; I shall then add the attestation, as to the accuracy of my Description and Tables, of those Members of the Royal Society, who have examined my Preparations, and Figures taken from them; and I shall conclude with a few Observations on Professor SCARPA's Work.

TREATISE



TREATISE THIRD:
ON THE EAR.

CHAP. I.

Of the Size, Shape, and relative Situation,
of the Cavities of the Ear.

THAT the Size, Shape, and relative Situation, of the Cavities of the Ear, might be more distinctly perceived than they can be by cutting the Bones in the common way, I propos'd to my Son, to fill them with Metal, and then to destroy the Bone; which he executed very dexterously and successfully: And in Four Figures of Table I. an exact Representation

Representation is given of his Preparation, from Drawings of it by Mr FYFE ; to which, with its Explanation, I shall refer the Reader. The Cochlea, in particular, is so completely filled as to give an excellent view of its Size and Figure.

In Table II. I have represented the appearance of Caverns in different kinds of Quadrupeds, resembling in office those of our Mastoid Process. These are, in proportion, considerably larger, and their sides thinner and more elastic, than in Man ; and there can be no doubt, that the greater Acuteness of those Animals in Hearing, is, in part, owing to the Structure of these Caverns.

C H A P.

CHAP. II.

Of the Structure of the Human Cochlea.

SECT. I.

IT has been long known, that the Human Cochlea describes two complete *Gyri* or Turns, and a Half Turn; that a central conical osseous Pillar, called *Modiolus*, is continued to the Middle of its Second *Gyrus*; that the *Gyri* are divided, by a Partition called *Lamina Spiralis*, into Two Winding Canals, called *Scale*; that one *Scala* begins from the Vestible, and is therefore called *Scala* of the *Vestible*, and that

B b

the

the other begins at the *Foramen Rotundum* in the Backpart of the Cavity of the *Tympanum*, and is therefore called the *Scala* of the *Tympanum*; that the *Scalae* are Wider at the Vestible and *Foramen Rotundum* than at the Apex of the Cochlea, or, that they are of a Conical figure; that at the Apex of the Cochlea they communicate with each other, by opening into a Common Tube, called *Infundibulum* or Funnel, one End of which begins at the Termination of the *Modiolus*, and the other End of it is fixed to the osseous Top or Cupola of the Cochlea.

S E C T. II.

IT is evident, that the Osseous Structure of the Human Cochlea must be fully explained, before we can describe its Membranes and Course of its Nerves; and as some material circumstances have escaped the observation of Authors, I shall give a short Description of this, illustrated by Figures.

The Central Pillar of the Cochlea consists of Two Parts, called *Modiolus* and *Infundibulum*.

The

The Modiolus is not a solid Osseous Cone, as has been generally supposed, but may be considered as a Hollow Cone, containing that Branch of the Portio Mollis which is destined for the Cochlea; and is everywhere Cribriform, for the Passage of the Branches of that Nerve. The Infundibulum is an imperfect Osseous Funnel, connected to the Top of the Modiolus. So that the Modiolus and Infundibulum are Two Hollow Conical Bodies, connected together by their small Ends. The Plate which is between them, and in the Centre of both, is Cribriform. Around the Modiolus, the First Gyrus of the Cochlea and Half of the Second Gyrus are described; the other Half Gyrus incloses the Root of the Infundibulum; and the Upper Ends of the Gyri, which communicate with each other, are covered or inclosed by the Cupola of the Cochlea.

The Partitions of Bone which separate the Gyri from each other, are not composed of One Solid Plate, as Authors have represented *, but consist of Two Plates, connected to the Modiolus at some distance from each other.

B b 2

The

* Du VERNEY.—CASSEBOHM, T. 5. F. 7, 8, 9, 10.—SCARPA, P. 10. F. 3. 7.

The Osseous Root of the Lamina Spiralis is likewise composed of Two Plates, connected to the Modiolus or Root of the Infundibulum, at some distance from each other.

I have already observed, that the Modiolus is composed of a Cribriform Hollow Cone, the Sides of which consist of Two Thin Plates ; and the Holes in it are much more Numerous than they have been described to be by Authors, and are not disposed in the Regular Manner they have represented them*.

They are to be seen in every part of the Surface of the Modiolus ; but are most numerous close to the Roots of the Osseous Septa which separate the Gyri from each other ; and close to the Outer Sides of the Root of the Lamina Spiralis. They are numerous in the Plate between the Modiolus and Infundibulum ; and when the Osseous Septa and Lamina Spiralis are cut near the Modiolus, they are seen in the Side of the Modiolus, between the Two Plates which compose the Septa and Lamina Spiralis.

In

* CASSEBOHM, T. 5. F. 10.

In Table III. the Osseous Structure of the Cochlea is accurately represented, magnified to Five Diameters; and a full Explanation of it is annexed, to which I shall refer the Reader.

S E C T. III.

It had been, and still is, generally supposed, that the Portio Mollis is distributed upon the Periosteum lining the Cochlea and Semicircular Canals: But, the extraordinary Hardness and Thickness of these Bones, the Smallness of the Holes by which the Nerves enter, and the great Delicacy and Tendernefs of the Membranes within the Cochlea,—had prevented Anatomists from tracing the Course of the Branches of the Portio Mollis within the Os Petrosum, and from perceiving the nature of the Interior Membranes, and the manner in which the Nerves terminate upon these.

To

To shew the Reader how little was known upon these subjects, I shall quote, at the bottom of the page, the account given of them by the most eminent Anatomists of the present century*.

As

* VALSALVA, de Aure Humana, Cap. iii. § 14. "Vidique demum minima
"quædam foramina, per quæ nervæ fibrillæ Cochleam subeunt. Intra
"hanc vero eadem *probabiliter* in membranam expansæ."

WINSLOW, Exp. An. P. 2. S. x. § 409. 1732. "La Portion Molle du Nerf
"Auditif aboutit par son tronc à la grande fossette du Trou Auditif Interne, ou
"les filets de ce tronc passent par plusieurs petits troncs de la base du Limaçon,
"en partie au Perioste des Canaux demicirculaires, en partie au Perioste Interne
"des demi-canaux du Limaçon." He says nothing of their appearance or distribution on this *Periostum*.

CASSEBOHM, de Aure Humana. 1734. Tr. v. § 227. "Neque in Cochlea
"Humana filamentum nerveum unquam observavi."

HALLER, El. Phys. Lib. xv. § 38. 1763. "Nervum autem aliquem in conspicua filamenti specie, per Cochlea spiras circumduci, (uti pingit VALSALVA),
"nunquam vidi. Sed nequidem, manus Anatomicæ, etiam summa industria, Nervulos ex modiolis per foramina, jam a nobis exposta, aut in scalam cochleæ alterutram, aut in duplicis laminæque spiralis membranaceum complementum, efficientis periosteï intervallum duxerit."

HALLER,

S E C T. IV.

As, previous to 1756, when I first attempted to trace the Portio Mollis within the Cochlea, I had repeatedly rendered
Injected

HALLER, in Pr. Lin. Phys. § 493. "Alter ramus, qui Cochleæ fulcum subit, "obscuram finem habet."

COTUNNIUS, de Aquod. Auris Hum. 1761. § 25. "Continuari tamen hos "nervorum ductus cum canaliculis inter lamellas spiralis laminæ descriptis (xiv.); "perque hos ad intervallum zonæ cochleæ nervorum ramulos transire, etsi pro "summa tenuitate rerum *non videam inspexisse*, extra omne tamen dubium asseri "posse credo. Ultra de hoc nervo me nihil scire, sincerus fateor."

J. FR. MECKEL junior. 1777. § xxiii. p. 40. "Aperto enim cochleæ tubo "a foramine rotundo ad usque tertium ipsius gyrum, ita ut, supra et infra sep- "tum utraque scala periosteo induta lustrari potuerit, etiam vitrorum, objecta "multum augmentum, ministerio, nil intueri licuit, nisi albas inter trabeculas Co- "chleæ strias."

MARTIN, de Nervis. 1781. S. 2. p. 82. "Vasculum aliquod sanguiferum "pro nervo habitum est, vel etiam portiunculæ membranarum filamentorum simi- "litudinem retulerunt."

SABATIER. 1781. T. 3. p. 252. "Mes observations n'ont pu me donner "des lumieres sur un chose aussi obscure."

Injected Bones soft and transparent, and, in doing so, had remarked, that, though the Bones were made very Tender, the Membranes connected with them retained a considerable degree of Tenacity, it readily occurred to me, that by this means I might be enabled to trace the whole progress of the Portio Mollis.

Accordingly my success equalled my expectation; and with a great deal of pains I detached the Os Petrosum, and the whole External Osseous Shell of the Cochlea from its Interior Membranes; and then took out the Membranes, with the Modiolus and Lamina Spiralis suspended by the Trunk of the Portio Mollis: So that, by proper dissection, I could trace and see distinctly, not only the Division of the Portio Mollis into its Larger Branches, but the whole Progress and Termination of these.

I found, That the Portio Mollis is composed of Two Branches nearly equal in size; one of which supplies the Vestible and Semicircular Canals, and the other the Cochlea. See Nervous System, Tab. XXX. Fig. 1, 2, 3, 4, 5.

That each Branch consists of a great Number of Small Cords. See Nervous System, Tab. XXXI. Fig. 1, 2, 3. A A.

That

That the Small Cords of both Branches pass through different minute Holes into the Vestible and Cochlea, or, that the Bottom of the Canal in the Backpart of the Os Petrosum, commonly called Meatus Auditorius Internus, is Cribiform. See Nervous System, Table XXIX. Fig. 12. X Y Z *cc d e.*

As the Osseous Partitions which divide the Cochlea into its Gyri, as well as the Lamina Spiralis which divides the Gyri into Scalæ, are connected to the Circumference of the Modiolus; we might expect to find the Branches of the Portio Mollis conducted, from the Modiolus, to the Membranes lining the Cochlea, by means of these Partitions, or between or along the outer-sides of the Two Osseous Plates which compose them, as well as between the Two Lamellæ which compose the Lamina Spiralis, or along the outer-sides of these; as we would suppose, that the Two Sides of each Scala should have Nerves distributed on them in the same manner.

Accordingly, on prosecuting the Branches or Fibres of the Portio Mollis with the utmost attention, I find, that they pass Outwards from the Cavity of the Modiolus, through innumerable minute Holes or Canals, which every where

C c

perforate

perforate it. Some Fibrils pass between the Two Plates which form the Septa that separate the Gyri from each other. A still greater number of Fibrils passes through Holes between the Two Plates which compose the Root of the Lamina Spiralis. But by far the greatest number of the Nervous Fibrils perforates the Sides of the Modiolus, between the Osseous Septa and the Lamina Spiralis. The Fibrils which pass through the Holes that are nearest to the Lamina Spiralis, run to the Membrane covering the Lamina Spiralis; whilst those which are nearest to the Septa, run, in a contrary direction, to the Membranes covering the Septa. We perceive, therefore, that the part of the Membrane lining each Scala which is the most distant from the Modiolus, will be supplied by the Terminations of these Two Sets of Fibrils meeting. The Nervous Fibrils on the Surface of the Lamina Spiralis, seem larger, and are more regularly disposed, than those that run on the Surface of the Septa. Two Plates are found in the Outer Osseous Part of the Lamina Spiralis, and the Space between them is filled with Nervous Fibres, from which numerous minute Fibrils issue between the Outer Edges of the Two Plates. There are likewise minute Holes in the Sides of each of the Plates which compose the Lamina Spiralis; and there can be no doubt

doubt that the Nerves between the Plates are connected with those which run on their External Surface.

The last Branches or Fibres of the Portio Mollis pass through the Cribriform Plate, in the Top of the Modiolus, which is common to it and the Infundibulum, to supply the last Half-Gyrus and Cupola of the Cochlea. See Nervous System, Table XXXI. Fig. 1, 2, 3. and Table IIII. of this Work.

I next observed, that the several Branches of the Portio Mollis, in their whole course along the Lamina Spiralis, formed an elegant and intricate Plexus, by innumerable Joinings and Separations of their component Fibrils. See Nervous System, Tab. XXXI. Fig. 1, 2, 3, 4. and Tab. IIII. Fig. 1, 2, 3.

At the Root or Osseous Part of the Lamina Spiralis, the Nerves are White and Opaque; but at the Flexible and Membranous Parts they are Semipellucid. See Nervous System, Tab. XXXI. Fig. 1, 2, 3, 4. and Tab. III.

This Change of Colour is like to that we observe the Optic Nerve undergoes on entering the Eyeball to form the

Retina : and, in both, the Change of Colour is not very gradually made, but suddenly.

On comparing the Semipellucid Outer-part of the Lamina Spiralis with the Retina of the Eye, I observed a remarkable difference ; to-wit, that in the Retina the Texture seems Pulpy and Uniform, without any such appearance of Fibres and Network as we might expect to observe from the name *Retina*, which has been so long and universally given to it ; whereas, in the Ear, Fibres and the Continuation of an intricate Network can be seen distinctly in the Semipellucid Part of the Lamina Spiralis, and as far as to its Outer Edge. See Nervous System, Tab. XXXI. Fig. 4. E F G. and Tab. IIII. Fig. 1, 2, 3.

I have, therefore, in my Lectures, long observed, that the term *Retina* was improper when applied to the Nerve spread out on the Bottom of the Eye, and had been given, not in consequence of accurate observation of the Structure, but from a common favourite theory of Anatomists, which supposes that the Brain and Nerves consist of Fibres. In the Ear, the term may be, with great propriety, applied to describe the Appearance of the Branches of the Portio Mollis in their course on the Lamina Spiralis.

At

At the Outer-part of the Lamina Spiralis, the Nervous Fibres and Network become much less evident; and, upon the Continuation of these Membranes, on the Inner-sides of the Gyri of the Cochlea, the Nerves seem to terminate in a Semipellucid Pulpy Substance, very like to the Retina of the Eye.

S E C T. V.

I WOULD next observe, that the Membrane on which the Branches of the Portio Mollis terminate in the outer transparent part of the Lamina Spiralis and on the Inner-sides of the Gyri of the Cochlea, is not the Periosteum of the Lamina Spiralis or of the Gyri, as has been universally supposed, but is as different from it as the Pleura is from the Periosteum of the Ribs. It is thick, soft, demipellucid, and but slightly connected to the Inner-sides of the Gyri; and, tracing the Branches of the Portio Mollis, it is evidently formed by them carrying with them their Pia Mater, nearly as the Retina is formed by the Optic Nerve. Besides, after detaching it from the Inner-sides of the Gyri, the Bone is so far from appearing bare, that we see Blood-

vessels

vessels running upon its Surface, supported by Membrane, which is indeed so thin and tender that we cannot easily raise it by dissection, but we can shew it as distinctly as the Periosteum which lines the Cavity of the Tympanum.

C H A P.

CHAP. III.

Of the Ear in Whales.

SOUND, I formerly observed*, is conveyed to the Bottom of the Ears in Whales, by the same general Structure as in Man and Quadrupeds.

They are all provided with a Meatus Auditorius Externus, the Orifice into which, in the Cete Delphinus, is extremely small; and it appears to me probable, that they possess the power of shutting it, and excluding the water, when they plunge to a considerable depth. In the Cete Balæna, (1. of LINNEUS), the largest of the Whale kind, there is within
the

* In my Book on Fishes.

the Meatus Auditorius a Hard Body, upwards of an Inch in Length, shaped like an Egg, and attached by its small end to one side of the Meatus ; which undoubtedly serves as a Valve, to prevent the Water, when the Whale dives deep, from over-distending and rupturing the Membrane of the Drum †.

Their Membrana Tympani is tied by a Chain of Bones to the Bottom of the Tympanum ; but in this Chain the Os *Orbiculare* is wanting, at least it is so in the *Phyfeter* ; and the Malleus is more fixed in its place than in Man.

I found, that they have likewise an Eustachian Tube, or Internal Meatus Auditorius ; and that Cells, much larger in proportion than those of our Mastoid Process, communicate with the Cavity of their Tympanum. See Tab. V. Fig. 5. and Tab. XXXV. Fig. 5, 6. on Fishes.

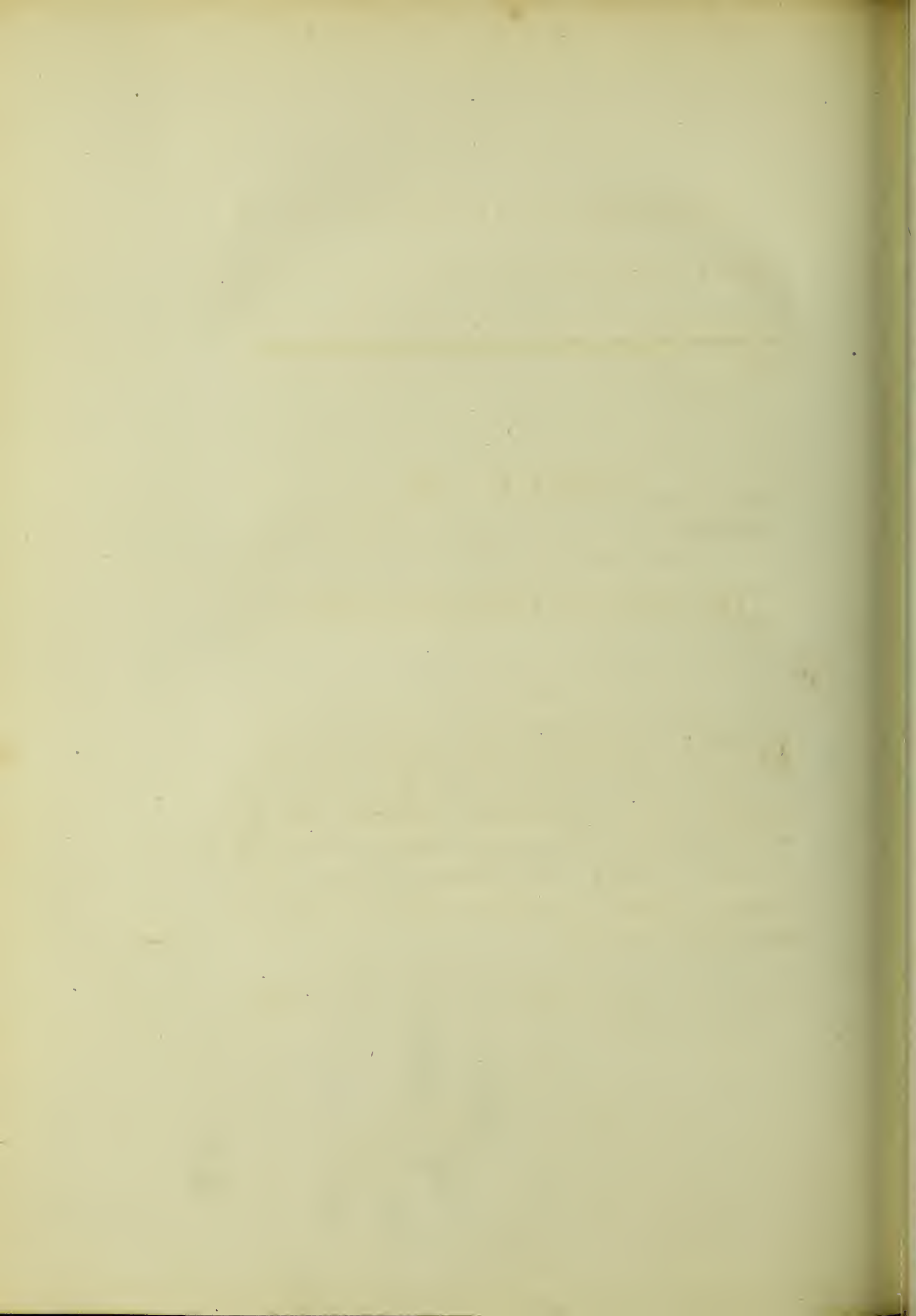
Their Cochlea and Semicircular Canals, I observed, were analogous to ours.

When

† See, in Table VI. *, a Figure of this, of its Natural Size, taken from a Preparation I received lately from Mr CLAPERTON.

When I first published on the subject, I thought it unnecessary to trace their Semicircular Canals with accuracy. But finding, by Dr CAMPER's Letter, that he, after having dissected various Species of the Whale, persisted in denying their existence, I have resumed the subject with greater attention: And, after finding that I had been under no mistake in describing Semicircular Canals, I asked Mr FYFE to bestow some pains in tracing their whole Extent, first in the *Delphinus Phocæna*, and afterwards in the *Delphinus Delphis*, and in the *Cete Phyfeter Macrocephalus* or *Spermaceti* Whale, which last Dr CAMPER had dissected; and to draw accurate Figures of them; to which, and their Explanation, I refer the Reader. See Tab. V. and Tab. VI.

On viewing these Figures, the Reader will observe, that the Cochlea in the *Cete Phyfeter* is much larger than in Man, but that the Semicircular Canals are smaller: And, so far as I have examined the Ear, I have found, that the Semicircular Canals in Man, bear a larger proportion to the Cochlea, than they do in the Quadruped or Whale.



C H A P. IV.

Of the Ear in Cartilaginous Fishes.

BEFORE I published my Work on Fishes, I had examined this subject with great attention; and have the satisfaction to find, on repeating my experiments, that my observations were correct in every respect: So that the descriptions I am about to give, contain a repetition of what I formerly published, but illustrated with more elegant Figures drawn by Mr FYFE.

I shall confine my descriptions chiefly, and almost entirely, to the Skate Fish *.

In the upper and back part of the Head of a Skate, and in a large Fish weighing 150 pounds, at the distance nearly of One Inch from the Articulation of the Head with the First Vertebra of the Neck or Atlas, Two Orifices, capable of admitting small-sized stocking-wires, at the distance of about an Inch and Quarter from each other, surrounded with a firm membranous Ring, may be observed. See Tab. VII. Fig. 1, 2, 3. Letters *a a a a*. These are the Beginnings of the Meatus Auditorii Externi.

If the Finger be applied a little farther forwards and inwards than one of these Orifices, and Pressure made with it, a White Viscid Matter will generally be squeezed out at the Orifice.

If

* See Tab. VII. in the First Figure of which the parts are represented as they appear on dissection. In Figures Second and Third, they are represented as they appeared, in a Fish weighing 150 pounds, after being stretched with melted wax injected into them.

If a Small Probe be introduced at the Orifice, and a Cut made upon the Point of the Probe, we discover a Winding Canal, nearly two lines, or the sixth part of an inch, in Diameter, which describes more than three-fourths of a Circle. See the same Figures, Letters *b b b b*. This Winding Canal may be compared to the Concha of our External Ear.

From the Concha, a Straight Passage, capable of admitting a small stocking-wire, leads outwards and downwards, (See in the same Figures the Letters *c c c*), to terminate in a Large Sac *d d d d*; which we may compare to the Vestible in the Human Body; and which, in the Skate, contains a very viscid pellucid Humour, like the glaire of an egg, and likewise a soft cretaceous Substance.

On the anterior part of the Large Sac, there is a much Smaller Sac *e e e e*, containing similar Matter, and communicating freely with the Large Sac at the Letters *f f f f*; and at the posterior part, there is a third very Small Bag, likewise containing cretaceous Matter, projecting from and communicating with the Large Bag.

We next find Three Semicircular, or rather Circular, Membranous Canals. In each of them, there is a Bulb or dilated.

ted part. All of them are inclosed within Cartilaginous Canals, lined with Perichondrium, which are considerably larger than the Membranous Canals. The Membranous Canals are filled with viscid pellucid Humour, like to that which is within the Vestible; and a Fluid resembling this, is lodged between the Perichondrium and the Membranous Canals; and these are tied to each other by Cellular Threads, on which Arteries, corresponding Veins, Lymphatics, and very minute Nerves, are dispersed. See Table XXXVII. Fig. 4. of my Work on Fishes.

One of these Canals is Anterior, See Tab. VII. Fig. 1, 2, 3. Letters *b i k l o*; and the part *k* is almost over the part *o*, or this Canal may be called Anterior Perpendicular: At *l* its Bulb is found. The Second or Middle Canal *m n*, is placed almost horizontally; and its Bulb is seen at *n*.

The Anterior and Horizontal Canals join together, and the wide Canal *i b o* is common to them. This Canal, common to the Anterior and Horizontal Canals, communicates with the Small Sac *e*, by means of the Membranous Tube *g*.

The

The Third Circular Canal is Posterior, and one half of it is over the other; so that it may be called Posterior Perpendicular Canal. See *q r f*. Its Bulb is at *f*. This Canal communicates with the Large Sac or Vestible, by means of the Duct *p*; but has no direct communication with either of the other two Circular Canals.

Upon the whole, then,—The Meatus Auditorius Externus leads to the Cavity of the Vestible. From this there is a Passage into a Smaller Sac, and, at the same place, a Duct leads into the Membranous Canal which is common to the Anterior and Horizontal Canals. From the Posterior Part of the Vestible, a Canal makes a Communication between the Vestible and the Posterior Canal. But the Anterior and the Horizontal Canal have no direct Communication with the Posterior Canal.

It appears, then, that from the Meatus Auditorius there is a Passage into the Large Sac or Vestible; and that from the Forepart of the Vestible, there is a Passage into the Small Sac, and, at the same place, into the Canal which is common to the Anterior and Horizontal Canals; and that, from the Backpart of the Large Sac or Vestible, there is a
Passage

Passage into the Posterior Canal; and, hence, that all parts of the Vestible and Circular Canals may be directly affected, in the living animal, or, after death, may be injected, through the Meatus Auditorius Externus.

C H A P.

CHAP. V.

Summary of the Chief Circumstances above described.

AS several of the principal Facts I have described, have, most unaccountably, been called in question, by Dr CAMPER and Professor SCARPA, I find myself under the disagreeable necessity of enumerating, in a summary way, the Chief Points, respecting the Organ of Hearing in Man and other Animals, in which, I apprehend, I have added to the former stock of knowledge; and of then subjoining the Attestation of the Royal Society of Edinburgh concerning them.



A. In the Human Body, I have shewed, That the Nerves of the Vestible and Semicircular Canals, as well as those of the Cochlea, pass through numerous Small Holes or Cribri-form Plates of the Os Petrosum *.

B. That all the Branches of the Portio Mollis which supply the Cochlea, pass through innumerable Small Holes of a Thin Conical Cribriiform Plate which forms the Modiolus †.

C. That minute Nerves pass through the Axis of the Modiolus, to perforate that part of the Cribriiform Plate which is common to it and to the Infundibulum, to supply the Infundibulum and that part of the Cochlea which it includes ‡.

D. That

* See Nervous System, Tab. XXIX.

† See Nervous System, Tab. XXIX.

‡ See Nervous System, Tab. XXXI.

D. That Branches of the Portio Mollis pass along and between the Lamellæ of the Osseous Septa which divide the Cochlea into its Gyri *; or, that all of them are not conducted by the Lamina Spiralis, as SCARPA has described and delineated †.

E. That the Nerves, in their whole course, particularly along the Lamina Spiralis, join and again are separated, so as to form a most elegant Plexus; in which new Combinations of the Nerves are formed ‡.

F. That the Nerves terminate on the Inner-sides of the Osseous Gyri, in a demipellucid soft pulpy Membrane, resembling the Retina of the Eye ||.

E e 2

G. That

* See Nervous System, Tab. XXXI. and, of this Treatise, Tab. III.

† SCARPA, P. 55. and Tab. VIII.

‡ See Nervous System, Tab. XXXI.

|| See Nervous System, Tab. XXXI. and, of this Treatise, Tab. III.

G. That this soft pulpy Membrane is not the Periofteum of the Cochlea ; but as different from it, as the Pleura is from the Periofteum of the Ribs.

H. In Whales, I have found an Eustachian Tube, which had not been described by Authors : I have shewn, that Semicircular Canals are not wanting, as was affirmed by Dr CAMPER ; and, in the Porpoise, I observed, that the Membranous Substance, within the Gyri of the Cochlea, on which the Portio Mollis is distributed, might be separated from the Periofteum of the Cochlea still more easily than in Man*.

I. In the Tortoise, as an example of the Amphibia, I have described the Eustachian Tubes, and the Connexion of the several parts of the Ear, more accurately than had been done by former Authors † : And it may be worth while to add, that the Toad, as well as the Frog, is provided with an Eustachian Tube, as this is denied by GEOFFROY ‡.

K. In

* See Book on Fishes, Tab. XXXV. and, of this Treatise, Tab. V.

† See Book on Fishes, Tab. XXXVI.

‡ GEOFFROY sur l'Organe de l'Ouïe, 1778, p. 65,—71.

K. In some of the Pisces of LINNÆUS, I have not only described and painted the Connexion of the Semicircular Canals, and of Sacs which may be compared to our Vestible; but I have traced, with accuracy, the Course and Termination of their Nerves *.

L. In the Skate and Angel Fish, I have discovered the Orifices of the Meatus Auditorii; shewn the Winding of their Conchæ Aurium; the Terminations of their Meatus Auditorii in the Vestibles; the Communications of their Semicircular Canals with each other and with the Vestibles; and Distribution of their Auditory Nerves, and of the Circulating and Lymphatic Vessels of their Ears †.

M. Particularly, I proved, that the Semicircular Canals in Fishes were much smaller than the Osseous or Cartilaginous Tubes which inclosed them; and that, so far from their being composed of the Periosteum or Perichondrium of these Canals, there was a considerable Space
between

* See Book on Fishes, Tab. XXXIX.

† See Book on Fishes, Tab. VII. XXXVII. XXXVIII. and, of this Treatise, Tab. VI. VII.

between them, and the Periosteum or Perichondrium, filled with Fluid, contained in a Cellular Substance, on which minute Nerves, with numerous Circulating and Abforbing Vessels, were dispersed, and conducted to the Perichondrium and Periosteum *. I observed farther, That in certain Fishes, of the genus Gadus, Spheroidal Bodies, which I had discovered, making in them part of the Nervous System, were dispersed in the Cellular Substance, between the Semicircular Canals and the Periosteum of the Tubes which contain them †.

C H A P.

* See Book on Fishes, Tab. XXXVII. XXXVIII. XXXIX.

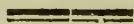
† See Book on Fishes, Tab. XXXIX.

C H A P. VI.

Attestation as to the Facts above described.

HAVING fully described, and illustrated by Tables, the Chief Parts of the Ear in the different Classes of Animals ; and having enumerated the particular Circumstances I have discovered which were unknown to former Writers ; I shall now add the Attestation of the Royal Society of Edinburgh respecting such facts as have been called in question by Dr CAMPER and Professor SCARPA.

At



AT their Meeting, in May 1794, I presented to the Society the following Letter :

“ GENTLEMEN,

“ AS one purpose of your Society is to ascertain such
“ Facts as are described by your Members or Correspondents,
“ I take this liberty to request of you to appoint a Commit-
“ tee, consisting of those Members whom you may suppose to
“ be the most competent Judges of Anatomical Matters, to
“ examine certain Subjects of which I propose to give, soon,
“ some account to the Society, illustrated with Figures.

“ I am,

“ GENTLEMEN,

“ Your most obedient Servant,

EDINBURGH, }
May 2. 1794. }

“ ALEXR. MONRO.

“ TO the PRESIDENT and OTHER MEMBERS of the ROYAL
“ SOCIETY.”

They accordingly appointed a large Committee of their number, with a general invitation to any others of their Members who might choose to be present.

In consequence of this, the following Gentlemen met, on the 9th of July 1794, in the Anatomical Theatre, at Mid-day, that they might have the advantage of examining my Dissections and Preparations with a clear light :

Mr JOHN ROBISON, Professor of Natural Philosophy.

Mr DUGALD STEWART, Professor of Moral Philosophy.

Mr PLAYFAIR, Professor of Mathematics.

Dr BLACK,	}	Professors of Medicine.
Dr FRANCIS HOME,		
Dr RUTHERFORD,		
Dr GREGORY,		
Dr DUNCAN,		

Dr ROTHERAM, Physician.

Dr WRIGHT, Physician.

Dr CHARLES STUART, Physician.

Dr THOMAS SPENS, Physician.

Mr JAMES RUSSEL, Surgeon.

Along with each of the Figures which I now publish, I demonstrated the Preparation from which it was delineated : And it is to be observed, that, in the Cartilaginous Fishes, I had injected, from the Orifice of their Meatus Auditorius Externus, not only Air and Quicksilver, but melted coloured Wax, into their Vestible and Semicircular Canals ; and that I have about twenty such Preparations in my possession.

The Committee, after having attentively examined these, hereby declare, That the Tables and Preparations correspond exactly ; and that they saw distinctly, in the Preparations, all that is represented in the Tables.

1795. May 14.

ON the 14th day of May 1795, I made the following Demonstration to my Colleagues, Dr HOME, Dr GREGORY, Dr RUTHERFORD, and Dr DUNCAN.

In Two Large Skates, one the *Raia Lævis*, the other the *Raia Aspera* or Thornback, I pointed out, with a Probe, the Orifices of the Meatus Auditorii Externi.

I then

I then pressed with my finger on the Fore and Inner Sides of these Orifices, and shewed them, that a white viscid Matter was discharged from them.

A Section was next made on the Right Side of both Fishes, and the Vestible and Semicircular Canals of the Ear were laid in view, without opening their Cavities.

A Small Iron Tube, fixed to a Large Glass Tube, was then introduced into the Orifice of the External Meatus Auditorius, and Quicksilver was poured into the Glass Tube. The Quicksilver entered readily, and filled the Concha, and stretched the Skin over it; so that its Shape, Size, and Winding, could be easily distinguished. From the Concha, the Quicksilver passed readily into, and distended, the Great Sac, which contains the Cretaceous Matter.—The Passage of the Quicksilver from the Meatus Externus Auditorius into the Sac or Vestible, was seen distinctly; because the Meatus terminates in that part of the Vestible which contains the clear viscid Matter, which is lodged between the upper and outer or posterior part of the Sac of the Vestible and the Cretaceous Matter.

They again examined the several Preparations in which the Concha, Meatus Auditorius, Vestible and Semicircular Canals, are filled with Wax of different colours in order to shew the Communication of these Parts, and they compared the Tables with the Preparations.

C H A P.

CH A P. VII.

Remarks on Professor SCARPA'S Book on the Ear.

BEFORE concluding, I find myself under the disagreeable necessity of pointing out the Injustice of certain Criticisms of Professor SCARPA, and of enumerating the many unaccountable Oversights and Errors he has committed ; and I shall quote the expressions he has thought himself at liberty to employ.

S E C T.

S E C T. I.

IN his Preface, p. 3. l. 25. he has asserted: " Nam
" quidquid nuperrimè MONROUS docuit de Acustici Nervi
" Distributione per Laminam Cochleæ Spiralem, nihil aliud
" est præter mirificæ fabricæ specimen; nec qua ratione
" Auditorius Nervus ad Utrumque Scalarum Cochleæ Gyrum
" pertingat, nec quo abeat Nervus ille qui per Centrum et
" Axin Modioli descendit, Vir alioquin cl., nobis patefe-
" cit."

The Reader, however, will observe, that I have not only every year, since 1756, shewed, in my Anatomical Courses, the Preparation from which the Figure I published was delineated; but that it was particularly examined, before I published, by the following Gentlemen: Dr SMITH, Reader of Anatomy in Oxford; Dr SOEMMERING, Dr MECKEL junior, Mr LUTHER, Dr BLACK, Dr HUTTON, Dr RUTHERFORD: (See my Book on the Nervous System, p. 45.): And that I still preserve the Preparation; and, on examining it again, after reading the above assertion, I find nothing materially

terially wrong in the Figure.—But, what is more directly in point, so inconsistent is Dr SCARPA, that, in the 55th page of his Work, where he describes the Pencils of Nerves passing from the Modiolus along the Lamina Spiralis, he quotes my Book in the following words: “Horum Penicillorum specimen vide apud MONROUM, Nerv. Syst.” And if the Reader will take the trouble of comparing the Figures I published, (See Nervous System, Tab. XXXI. Fig. 1, 2, 3, 4.), with Professor SCARPA’s Figures, (Nat. Disq. Tab. VII. Fig. 1, 2.), he will find, that they correspond so much, in every general and material respect, that His Figure seems little more than the Transcript of mine. They differ chiefly in the way in which the Nerves are presented to view. In my Preparation, I took off, with great pains, the whole Outer Osseous Shell of the Cochlea, and then lifted out the Modiolus and Lamina Spiralis, suspended by the Portio Mollis; so that the whole Distribution of the Nerve on the Lamina Spiralis is seen: Whereas Professor SCARPA has cut open one side only of the Cochlea.

I will farther venture to assert, that although Professor SCARPA’s Figures are more shewy and elegant than my first
Figures.

Figures were, yet mine give a more distinct and accurate Representation of Nature.

He next alleges, That I had not shewn how the Nerves go to the Gyri of the Cochlea, as if he had shewn this better than I had done. But let the Reader compare our Figures; he will find, that Professor SCARPA does not paint the Nerves so far as I had done in my Book on the Nervous System. I painted them as far as distinct Branches could be seen with a Microscope which magnified the object to thirty diameters. My descriptions, when I published on the Nervous System, were indeed very concise; because I had the intention of prosecuting the subject still more fully than I had then done.

In the next place, it is to be remarked, that One-half of the Nerves the Scalæ of the Cochlea receive, has escaped the observation of Professor SCARPA *, to wit, All those which run along the Ossæous Septa to supply the Outer-part of each Scala, or that Part of each Scala which is most distant from the Lamina Spiralis.

But

* See SCARPA, Cap. III. De Nervo Auditorio, § viii.—xii. p. 54, 55, 56.

But I must farther observe, that Professor SCARPA, who describes the Portio Mollis as terminating in the Periosteum of the Cochlea, has neither attended properly to the Analogy of the Optic Nerves, nor to the Structure of the Membranes within the Cochlea; for, from the description and reasons I have given, it is evident, that the Periosteum, and the Pulpy Membrane in which the Portio Mollis of the Cochlea terminates, are Distinct Membranes, the former having the Common Structure, and the latter resembling the Retina of the Eye.

SECT. II.

IN my Book on Fishes, p. 49. I observed, That in each of the Membranous Semicircular Canals, both in the Ossëous and in the Cartilaginous Fishes, there is a Dilatation or Pouch: and, That the Membranous Canals are so much smaller, than the Canals of Cartilage or Bone which contain them; that, between them and the Cartilage or Bone, there is a viscid watery Liquor, contained in a Cellular Substance, on the Threads of which, Circulating and Absorbent Vessels, and Nerves, are dispersed. (*b.*) See Tab. XXXVII.

G g

I likewise,

I likewise, after describing the Size and Course of the Nerves, observed, in treating of the Cartilaginous Fishes, That "the Nerves, after reaching the Sacs and Canals, and "running a little way upon their Membranes, lose their "White Colour, become Pellucid, and disappear." In Tab. XXXVII. these Nerves are delineated from very large Fishes. And, speaking of the Osseous Fishes, p. 51. I observed, That "very large Nerves are fixed to the *Bulbous* "Parts of the Semicircular Canals, and, spreading out on "these Canals, they become suddenly Pellucid." See Tab. XXXIX.

Still, however, other pursuits diverted me from the intention I had long had, of tracing the whole Distribution of the Portio Mollis in the Human Ear.

In 1789, that is, four years after my Book on Fishes appeared, Professor SCARPA published his Description of the Membranes and Nerves of the Human Semicircular Canals: And, although it is evident, as he does not appear to have known any thing of the matter when he published his "*Observationes de Fenestra Rotunda et Tympano Secundario*" in 1772, and as he had then read my Works on the Nervous System and on Fishes, that he was led by the first of these

these to examine the Nerves of the Cochlea, and, on the supposition of analogy, to examine the Vestible and Semicircular Canals in Man; yet, instead of acknowledging this, he tries to insinuate, that I had not traced the Nerves of the Semicircular Canals in Fishes to their proper places, in order to give the appearance of originality to his own descriptions. Yet, after joining me with Mr JOHN HUNTER as the author of an assertion which Mr HUNTER alone made,—where he says, (in a note, p. 15.) “ J. HUNTERUS et MON-
 “ ROUS asseruerunt Canales Piscium Semicirculares, Nervos
 “ intus non fuscipere;” adding, “ Qua super re vereor quàm
 “ maximè Viros cl. examinassè tantummodo Cylindros, non
 “ quidem *Ampullas* simul Canaliculorum Semicircularium in Pesci-
 “ bus,”—he, in the same note, refutes the truth of his alle-
 gation, by subjoining the following quotation from my Book:
 “ Et MONROUS, loc. cit. “ After reaching the *Sacs* and Ca-
 “ nals, and running a little way upon their Membranes,
 “ they lose their white colour, become pellucid, and disap-
 “ pear.” And with this description of mine, that of Pro-
 fessor SCARPA exactly coincides: (See his Work, p. 34.
 § vi. l. 7.): “ Neque enim in Homine, prospero magis suc-
 “ cessu quàm in Piscibus, Reptilibus, et Avibus, quantacun-
 “ que adhibita diligentia, datum nobis fuit eam Pulpam, ul-

“ tra Ampullaram fines, per continuos .femicirculares Ductus
 “ membranaceos, propagatam videre.”

In Tab. VIII. Fig. 1, 2, 3. the Reader will find a more exact Representation of the Division of the Acoustic Nerve upon the Ampulla than Professor SCARPA could have given, as it can be seen in very Large Fishes only; which the rude and inaccurate Figure he has published, shews he had not examined.

S E C T. III.

PROFESSOR SCARPA, dissatisfied with the account I had given of the Structure of the Ear in the Cartilaginous Fishes, undertakes one more accurate, and has expressed himself in the following terms. His criticisms are strangely disjoined, and unnecessarily repeated; but I shall endeavour to arrange them so as to render them as intelligible as possible.

Præf.

Præf. p. 2. "Has ob causas Organi Auditus Cartilagineorum Piscium plenior, quàm adhuc factum est, descriptionem tradere suscepimus."

Præf. p. 1. "MONROUS Externum hoc Auditus Ostium (Rajæ) descripserit, fusiùs atque delineaverit.
"MONROUM vehementer super hac re hallucinatum fuisse.
" Etenim nullum prorsus adest *Ostium* Auditus *extus*
" *Adapertum* in Cartilagineis Piscibus, ejusque loco, sub *As-*
" pero horum Animantium Tegumento, *Fenestra Ovalis* reperiunda est, *Membranaceo Operculo*, a nemine adhuc memorato, obducta."

P. 8. § iii. "In Cartilagineis Piscibus nullum prorsus adest Ostium Auditus extus Adapertum, ejusque prænunciati *Ostii* loco, sub communibus tegumentis, *Fenestram Ovalem*, *Operculo* Membranaceo clausam, ostendimus," &c.

P. 9. § v. "Igitur in Summitate Capitis Rajæ ponè Occiput, qua nempè cum Prima Colli Vertebra Colli necitur, ablato Spinoso Tegumento, Sinuositas occurrit, in qua Membranulæ Duæ, ovalis figuræ Tympani ad modum tensæ, conspiciendæ sunt.

P. 9. § v. in a note at the foot of the page. "MONROUS,
 " in Opere cui titulus "Physiology of Fishes," Sect. III.
 " Tab. VII. Fig. 1, 2. docet in Raja, propè Juncturam Capi-
 " tis cum Spina, adesse Foramina duo exigua, quæ ad Aures
 " ducunt. Qua in re vehementer sibi hallucinatus est; Ostia
 " nimirum Ductuum Mucosorum, ut manifestum est, pro Au-
 " ris Meatibus accipiens. Etenim omninò nullum est in
 " Cartilagineis Piscibus Ostium Auditus extus Adapertum,
 " Membranaque Fenestræ Ovalis sub Communi Tegumento
 " recondita jacet et cooperta."

P. 9. § vi. Note (*d.*). "Minimè tamen ducit intra Ca-
 " vitates Sacculorum Vestibuli, quemadmodum MONROO vi-
 " sum est; cujus doctrina, si vera esset, simulque adessent
 " Ostia Auditus Externa, necessariò consequeretur liberum ef-
 " fe in Cartilagineis Piscibus Aëri et Aquæ Accessum ad se-
 " dem Organi Auditus immediati, ipsamque Pulpam Nervi
 " Auditorii; quod et absurdum est, et a rei veritate quàm
 " maximè alienum!"

Præf. p. 2. "Præterea, MONROUS nescio quam Organi
 " Auditus Cartilagineorum Piscium historiam conscripsit, ut,
 " nisi vehementer fallimur, ex ipsius sententia deducere uni-
 " cuique

“ cuique liceat in Piscibus Cartilagineis *Meatum* Auditus *Ex-*
 “ *ternum* ducere intra Sacculos Capillorum, atque ab his ad
 “ Canales Semicirculares, Nervumque Auditorium; proin,
 “ Aquis admixtisque heterogeneis particulis nullatenus in
 “ Cartilagineis Piscibus impeditam viam esse ab *Externo* (ut
 “ ait) *Auris Meatu*, ad immediatam Auditus sedem; quæ res
 “ profectò a veritate et perspecta Naturæ providentia quàm
 “ longissimè distat !”

P. 12. § xv. “ Interim præstabit monere, Canales Semi-
 “ circulares Membranofos, quamvis pluribus in sedibus La-
 “ pillorum Sacculis alligati sunt, nullibì tamen cum iisdem
 “ Sacculis communicare; quod *iteratis* periculis, modò
 “ Aërem, servata naturali sede, per Canales Semicirculares
 “ Membranofos insufflando, modò Hydrargyrum injiciendo,
 “ cognovimus.” — Note (*e.*). “ Minimè ignoramus MON-
 “ ROUM in Raja descripsisse ac delineasse.”

From the above quotations, then, it appears, that Professor
 SCARPA, even after having read and studied the Description
 and Figures I had given of the Structure of the Ear in the
 Skate, illustrated by a number of Tables, had not been able
 to discover the External Mouth, or OSTIUM, of the Meatus
 Auditorius ;

Auditorius; the Concha Auris; the Continuation of the Meatus Auditorius; the Termination of it in the Vestible, or Large Sac, containing viscid and cretaceous matter; the Communication of the Large Sac, or Vestible, with the Smaller Sac, nor the Communication of the Semicircular Canals with these Sacs or Vestibles. Yet, in my experiments, not only Air and Quicksilver readily passed in all directions; but, in a great number of Preparations in my possession, all the Passages and Communications I described in my former Work, are filled with melted and coloured Wax, and were distinctly seen by every Member of the Committee of the Royal Society of this place, and by many Students who have examined them.

One thing only, which might be apt to stagger such as have not had the opportunity of seeing my Preparations, remains to be explained; I mean what relates to a *Fenestra Ovalis*, which is mentioned by Professor SCARPA, "*Membræ naceo Operculo obducta, a nemine adhuc memorata.*"

If the Reader will compare my Book on Fishes, Tab. XXXVII. Fig. 2. with Professor SCARPA'S, Tab. I. Fig. 1. &c, he may observe this Fenestra delineated by me, and a large

large pin stuck through it, with the following explanation; page 115. l. 22. " Behind the Concha, there is a Large Soft Part, which is shewn by a pin stuck through it." I did not call it Fenestra Ovalis; because, as I had discovered a Meatus Auditorius Externus leading into the Cavity of the Vestible, I was certain it had no analogy to our Fenestra Ovalis: And Dr SCARPA, though ignorant of the existence of the Meatus Externus, might have perceived that it did not resemble the Structure of the Tortoise, to which he compares it, (in p. 16. § xxvii. l. 23.); for, as he immediately afterwards observes, (l. 27.) " In Cartilagineis Piscibus mox retrò Membranam Fenestræ Ovalis omisit Natura Ossiculum, quòd in Reptilibus plerisque altera extremitate Tympano nexum est, altera, stapedis ad modum, Fenestram Ovalem obstruit."

In Table VI. Fig. 2, 3, 4. T. I have given a still more exact Representation of this Soft Part.

I then supposed, and still do suppose, that Nature has formed one part of the Case which contains the Vestible and Semicircular Canals, Soft and Flexible, in order that, by its yielding, the Parts within might be susceptible of Tremulous

H h.

Motions

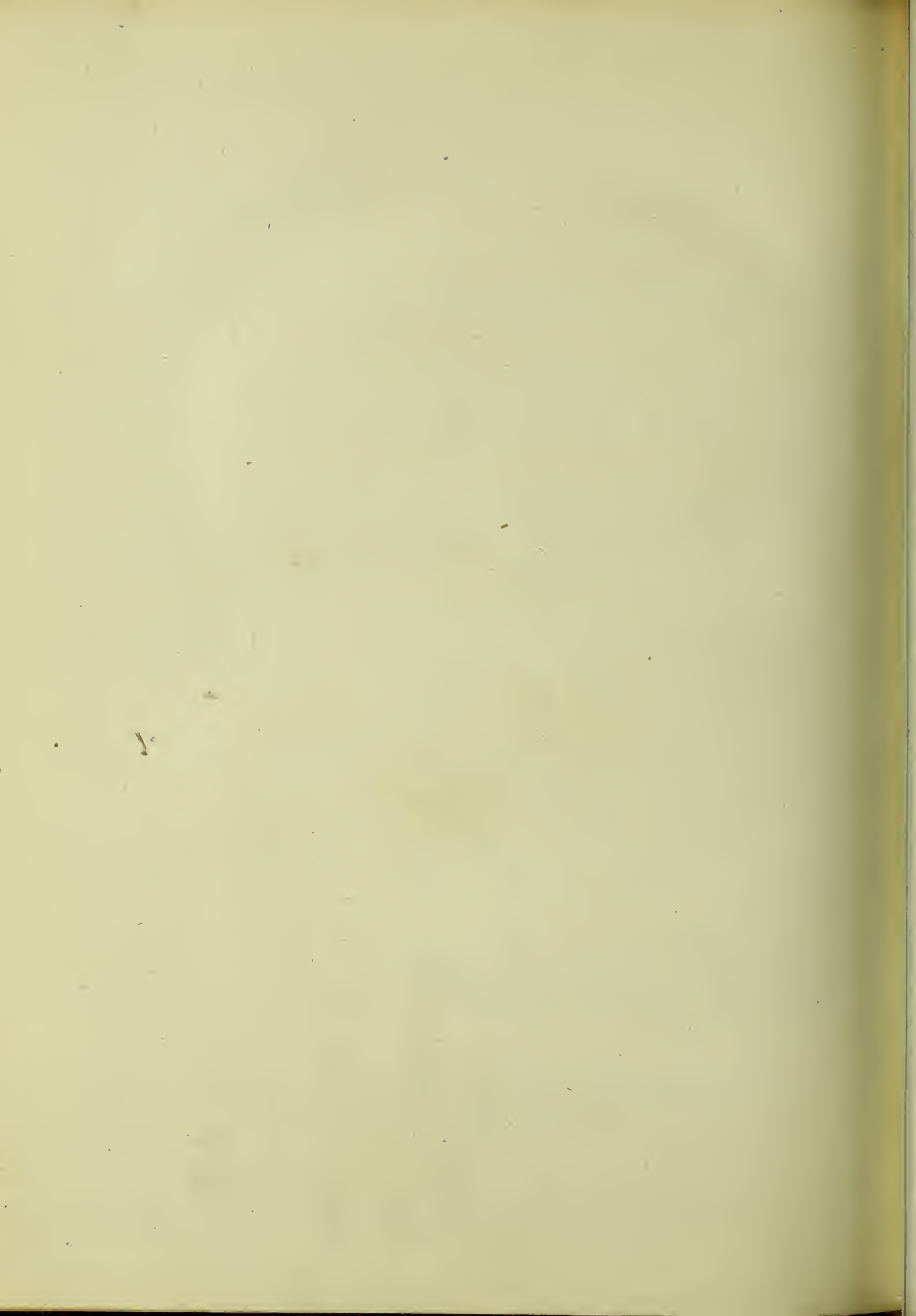
Motion when Sound acts upon them through the Meatus Auditorius Externus.

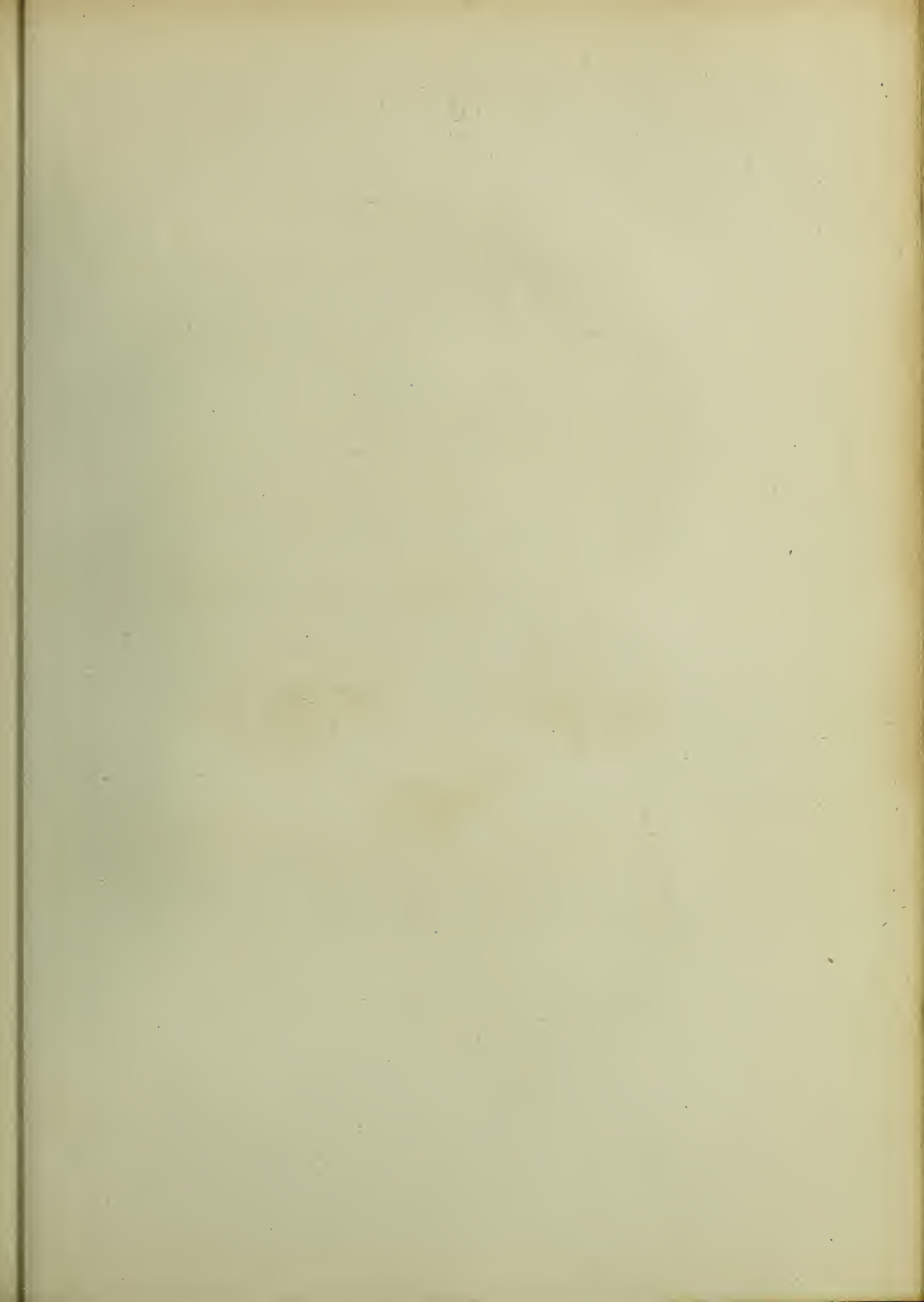
After establishing the fact, that the Skate and Squalus Squatina are provided with a Meatus Auditorius Externus, it must seem very superfluous to the Reader to take any notice of what Professor SCARPA has stated about the danger of Water and Heterogeneous Matter getting into the Vestible and Semicircular Canals, injuring the Auditory Nerve, &c. : Yet, I cannot help observing, that Professor SCARPA seems to have forgotten, not only that the Orifice of the Meatus is like that of the Whale ; but likewise, that, from the Obliquity of the Meatus or Concha under the Skin, there is no more danger of Air, Water, Sand, &c. getting into the Ear, than there is, that the Drink, the Chyle, or the Urine, shall get into the Salivary or Biliary Ducts or Ureters ; and likewise, that these Parts are quite full of Viscid Matter inclosed in Membranes, incased in Thick Cartilages, which therefore will resist the entrance of external Fluids or Solids.

Were

Were it worth while, I might observe farther to him, That I have, in the very same Animal, discovered and described two much larger Passages, with open Orifices, by which the Cavity of the Abdomen communicates with the Water of the Ocean; and, again, within the Animal, Tubes by which the Cavity of the Pericardium communicates with the Cavity of the Abdomen; yet the Interior Parts suffer no Injury *.

* See my Book on Fishes, Tab. XVIII. 10, 11. 29, 30.





TAB. I.

F. 3.



F. 1.



F. 4.



F. 2.

EXPLANATION
OF THE
T A B L E S.

Explanation of Table I.

THE Figures in this Table give an accurate Representation of Metal, with which the Cavities of the Human Ear, on the Right Side of the Body, had been filled.

F I G. 1, 2.

Fig. 1. represents the Forepart of the Metal, and Fig. 2. the Backpart of it.

a Represents

- a* Represents the Metal which filled the Osseous Part of the Meatus Auditorius Externus.
- b* The Ring where the Membrana Tympani was connected.
- T* The Cavity of the Tympanum filled.
- c* The Root of the Cells of the Mastoid Process where they communicate with the Cavity of the Tympanum.
- d e* The Metal which filled the Cells of the Mastoid Process.
- f* (Fig. 1.) The Canal filled which contained the Tensor Membrana Tympani.
- g* The Outer Osseous End of the Eustachian Tube filled.
- h* The Vestible filled.

i The

- i* The Cochlea completely filled.
- k* The Root of the Scala Tympani of the Cochlea.
- l* The Root of its Scala Vestibuli.
- m* (Fig. 1.) The Forepart of the Beginning of the Anterior Perpendicular Semicircular Canal filled.
- n* (Fig. 1.) The Forepart of the Beginning of the Horizontal Semicircular Canal filled.
- o* The Canal common to the Two Perpendicular Semicircular Canals filled.
- p q* (Fig. 2.) At the Places to which the dotted lines, drawn from *p* and *q*, lead, the other Ends of the Posterior, Perpendicular, and Horizontal, Semicircular Canals, are represented, filled with the Metal.

F I G.

F I G. 3, 4.

Fig. 3. shews the Metal with which the Cochlea had been filled, as it appears when we look into the Conical Cavity M, which the Modiolus had occupied, and which was not filled with the Metal.

Fig. 4. gives the same view of the Preparation magnified to Four Diameters.

a b c The Scala of the Tympanum filled.

d e Part of the Scala of the Vestibulum seen in this view. The rest of it, is hid by the Scala of the Tympanum.

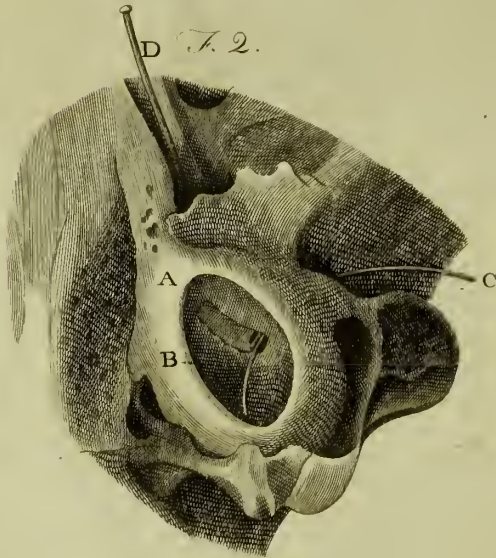
Explanation

TAB. II.

Fig. 1.



F. 2.



F. 3.



J. Wolfe del.

H. Schubert sculp.

Explanation of Table II.

THE Figures of this Table represent, in the Ape and different orders of Quadrupeds, remarkable Varieties of the Size and Shape of the Cavity of the Tympanum; and of its Communication with a Cavern, or with Caverns, analogous to those of our Mastoid Process.

F I G. I.

Represents the Under Part of the Bones of the Head in the Ape.

- A A Protuberance in the Under Part of the Left Os Petrosum.
- B A similar Protuberance of the Right Os Petrosum cut, to shew a number of Cells, without Marrow, which it contains, and which communicate with the Cavity of the Tympanum.
- C A Probe passed from the Meatus Auditorius into the Cavity of the Tympanum.
- D A Probe passed through the Eustachian Tube into the Cavity of the Tympanum.

These Protuberances, therefore, resemble in office our Mastoid Processes, but are differently situated.

Fig. 2. represents similar Protuberances in the Tiger, and Fig. 3. such Protuberances in the Sheep: But, on cutting them, Large Caverns, communicating with the Cavity of the Tympanum, are found, instead of numerous minute Cells.

In the Dog and the Horse these Protuberances agree so much, in situation and structure, with those of the Tiger and Sheep, that I thought it unnecessary to have the Drawings of them Engraved.

It may be worth while to observe, that, in the Ape, these Protuberances are situated as in the Quadruped; but, that their cellular structure corresponds with that of the Human Mastoid Processes.

Explanation of Table III.

IN this Table, the Osseous Structure of the Human Cochlea and Vestible is represented.

F I G. I.

This Figure shews, on the Left Side of the Body, the Passages for the Branches of the Portio Mollis into the Cochlea and Vestible; and the Cavity of the Vestible laid open, on its Backpart, by cutting away a Portion of the Inner and Posterior Part of the Os Petrosum.

* The

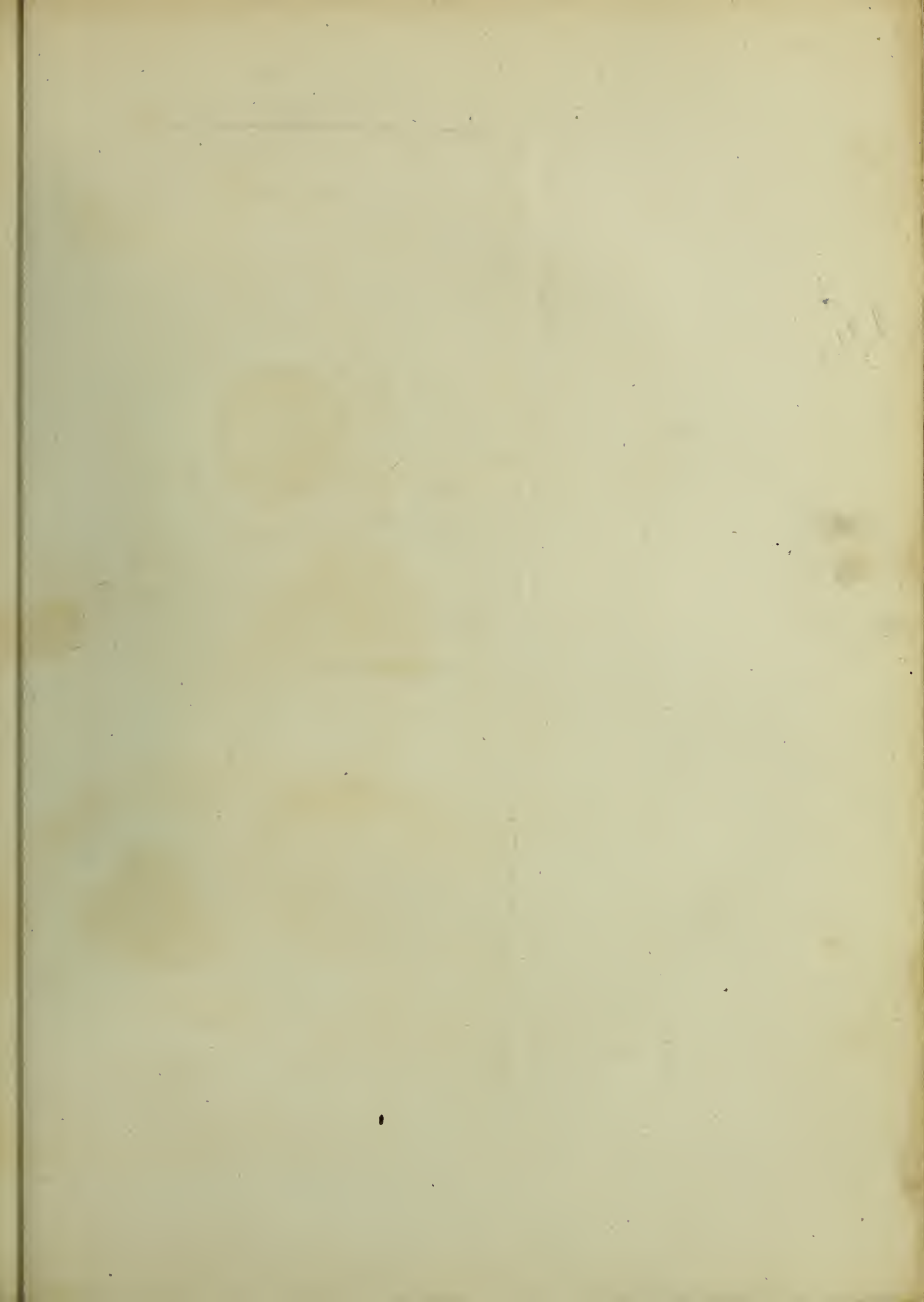


Fig. 1.

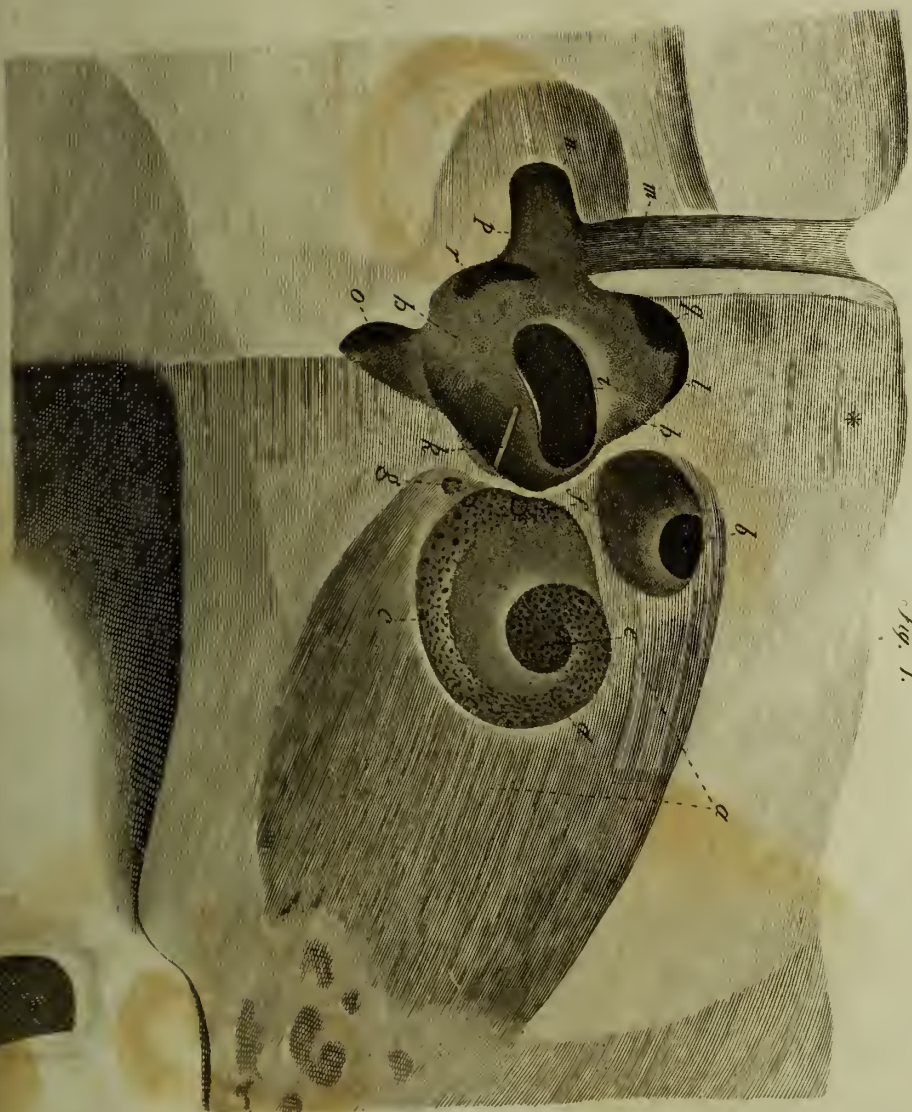
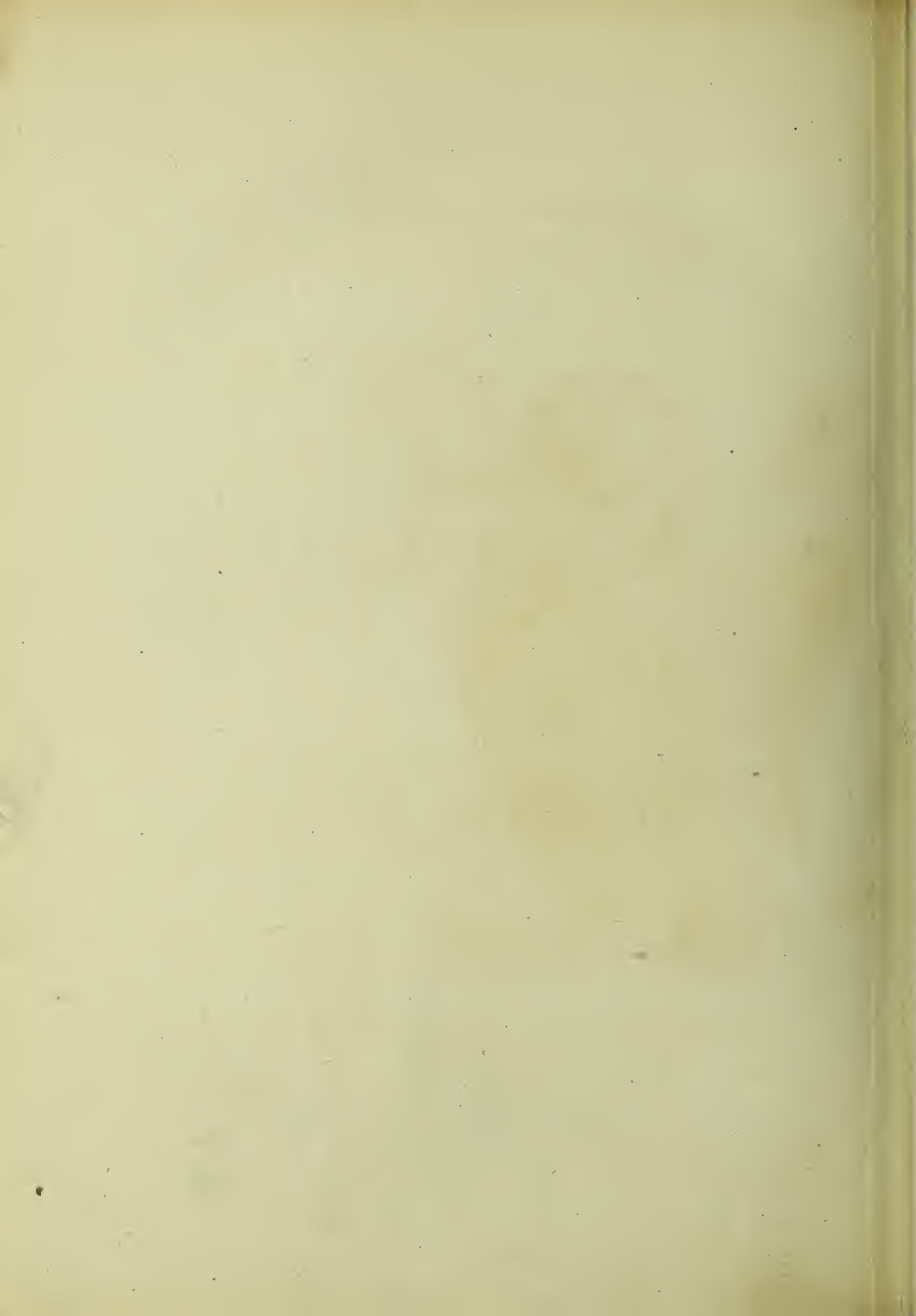


Fig. 2.



- * The Inner and Posterior Part of the Os Petrosum.
- a* The Bottom of the Canal which contains the Left Branches of the Auditory Nerves.
- b* The Canal of the Portio Dura of the 7th Pair.
- c d* A Cribriform Plate, through which the Branches of the Portio Mollis pass into the Cochlea.
- e* The Continuation of the same Cribriform Plate, forming the Centre and Bottom of the Cavity of the Modiolus.
- f g* Cribriform Plates, through which Branches of the Portio Mollis pass into the Vestible.
- b b* The Cavity of the Vestible laid open, by cutting away the Bone which covers its Posterior Part.
- i* The Foramen Ovale.
- k* A Probe passed from the Vestible, into the Scala Vestibuli of the Cochlea.
- l* The Anterior, and *m* the Posterior, End of the Superior Semicircular Canal.
- n* The Upper, and *o* the Lower, End of the Posterior Semicircular Canal.
- p* The Termination, in the Vestible, of the Tube which is common to the Superior and Posterior Semicircular Canals, or which is formed by the joining together of their Ends *m n*.
- q* The Fore, and *r* the Posterior, End of the Exterior Horizontal Semicircular Canal.

F I G. 2.

Gives a View, from above, of the Cochlea, and Part of the Vestible and Semicircular Canals, of the Right Side, after cutting away Part of the Os Petrosum.

- a* The Os Petrosum.
- b* The Canal for the Internal Carotid Artery.
- c* The Anterior End of the External Horizontal Semicircular Canal.
- d* The Anterior End of the Superior Semicircular Canal.
- e* The Upper Part of the Vestible.
- f* The Side of the Cochlea viewed somewhat obliquely.
- g b i i* The Outer Part of the Modiolus, which is Cribri-form, or pierced with a number of Holes, for the Passage of the Branches of the Portio Mollis.
- k* A Wire passed between Two Plates or Lamellæ, of which the Modiolus consists, and which are at the greatest distance from each other, and therefore best seen at its Root.
- l l* The Osseous Septum between the First and Second Gyrus of the Cochlea, composed of Two Tables or Plates.
- m* The Osseous Septum which separates the Second Gyrus of the Cochlea from the Infundibulum.

n o p The

- n o p* The First Turn of the Osseous Part or Root of the Lamina Spiralis. At *o* it is cut, to shew that it consists of Two Tables, between which Branches of the Portio Mollis are lodged, which, after dividing into very minute Filaments, pass through innumerable Holes, which are delineated on the Outer Edge of the Osseous Part of the Lamina Spiralis.
- q* The Second Turn of the Osseous Part of the Lamina Spiralis.
- r* The Termination of the Lamina Spiralis in a Hamus or Hamulus, the Concave Side of which is connected with, or continued from, the Osseous Septum *m*, which divides the Second Gyrus from the Infundibulum.
- f* The Infundibulum, at the Bottom of which a Cribri-form Osseous Plate is seen, between it and the Apex of the Modiolus, through which Nerves pass from the Modiolus into the Infundibulum.
- t u* The First and Second Scala of the Tympanum.
- v w* The First and Second Scala of the Vestible.

F I G. 3.

In this Figure, the Side of the Cochlea is turned a little more outwards than in Fig. 2. by which the Outer Edge of the Lamina Spiralis, and Structure of the Osseous Septum between the Scalæ of the Cochlea, are better seen.

a Represents.

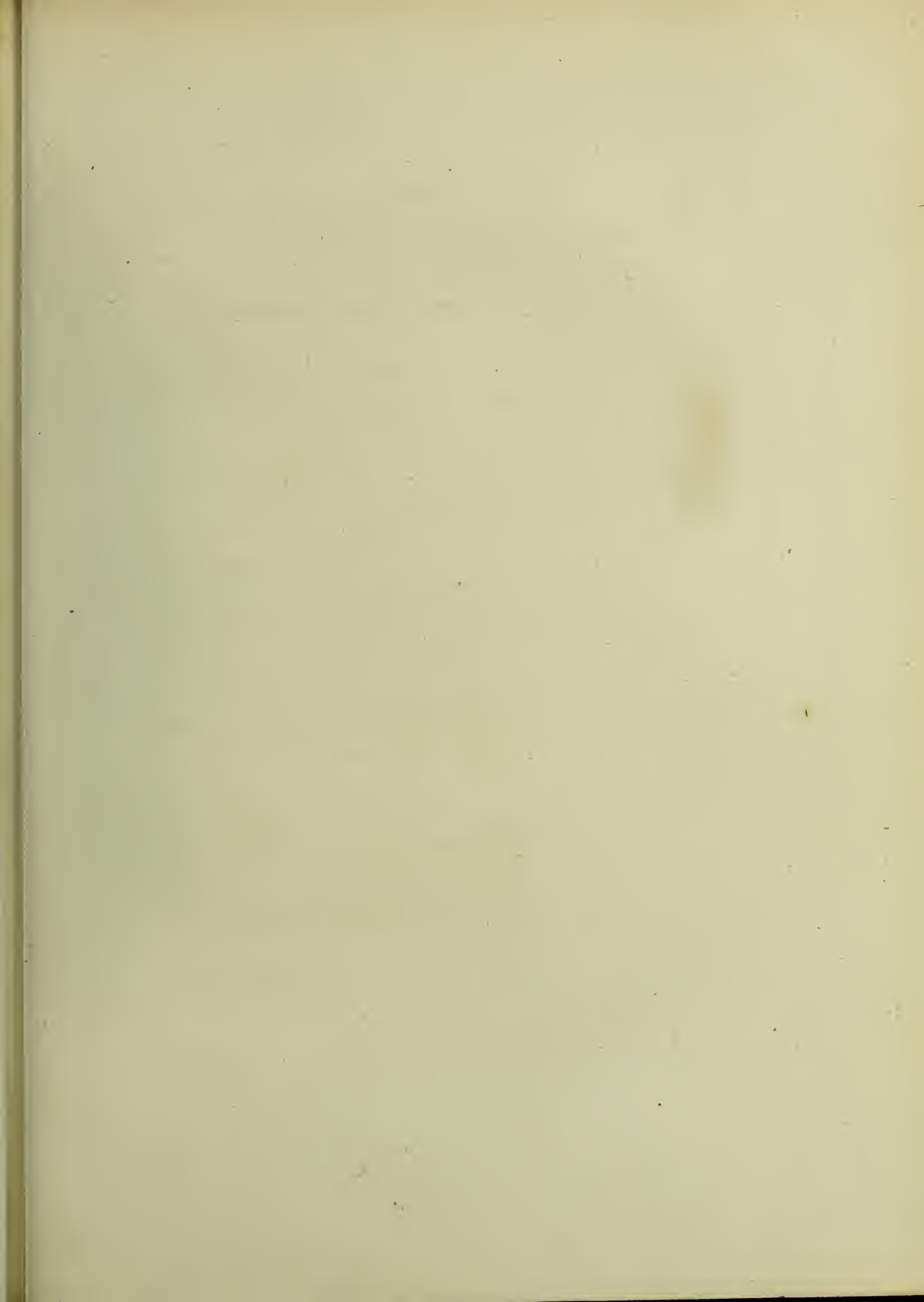
- a* Represents the Basis of the Cochlea.
- b* The Root of the Cribriform Modiolus.
- c* The Root of the Lamina Spiralis, which is likewise Cribriform.
- d* The Outer Edge of the Osseous Part of the Lamina Spiralis, where the Two Laminæ which compose it are seen, with innumerable Holes for the Passage of the Branches of the Nerves which are placed between the Laminæ.
- e* A Section of the Osseous Septum, which divides the First from the Second Gyrus of the Cochlea, and which consists of Two Laminæ.
- f* The Scala Tympani, and *g* the Scala Vestibuli.

F I G. 4.

Represents the Cochlea, and a small part of the Semicircular Canals, after cutting off from them the Fore and Outer Part of the Os Petrosum.

- a* The Fore and Outer Side of the Os Petrosum.
- b* The Passage for the Internal Carotid Artery.
- c* Part of the Vestible.
- d* The Anterior End of the External Horizontal Semicircular Canal.
- e* The Anterior End of the Superior Semicircular Canal.
- f* The Basis of the Cochlea.
- g* The Scala of the Tympanum.

b The



TAB. IV.

Fig. 2.



Fig. 3.



Fig. 1.



A. Juss. del.

M. bidentate Juss.

- b* The Outer Edge of the Osseous Part of the Lamina Spiralis, in which there are innumerable Small Holes for the Passage of Nerves.
- i* A Ridge in the Middle of the Osseous Part of the Lamina Spiralis, where the Two Plates which compose it are at such distance from each other as to produce a Rising or Ridge.
- k k* The Osseous Septum which divides the First from the Second Gyrus of the Cochlea.
- l* The Scala of the Vestible.
- m* The Second Gyrus of the Cochlea.
- n* The Lamina Spiralis, terminating in a Hamus or Hook.
- o* The Infundibulum.

Explanation of Table IV.

THE Three Figures of this Table represent the Distribution of the Branches of the Portio Mollis, within the Two Scalæ of the Cochlea, or the Nervous Webs or Retinæ these form.

F I G. 1.

Represents the Distribution of the Branches of the Portio Mollis, on one side of the Lamina Spiralis.

- a* The Large Branches of the Portio Mollis, at the Root or Osseous Part of the Lamina Spiralis.

b The

EXPLANATION OF TABLE IV.

- b* The Continuation of these Branches on the Soft Part of the Lamina Spiralis.
- c* The Outer Part of the Lamina Spiralis, separated from the Bone of the Cochlea.
- These Nerves, in their whole course, form an intricate and beautiful Plexus, by repeatedly joining into Trunks, and these separating into Branches.

 F I G. 2.

- M Represents the Modiolus.
- a* The Plexus of Nerves on the Osseous Part of the Lamina Spiralis.
- b* The Plexus of Nerves on the Outer and Softer Part of the Lamina Spiralis.
- c* The Outer Part of the Lamina Spiralis, dividing into its two constituent Layers or Membranes, one of which *d*, continued, lines the Scala of the Vestible, and the other Layer *e*, continued, lines the Scala of the Tympanum.

 F I G. 3.

- M Represents the Modiolus.
- b* The Plexus of Nerves on the Lamina Spiralis.
- At *c*, the Layer of the Lamina Spiralis, the Continuation of which formed the Retina of the Scala of the Tympanum, is cut off.

• *d* Shews



FIG.V

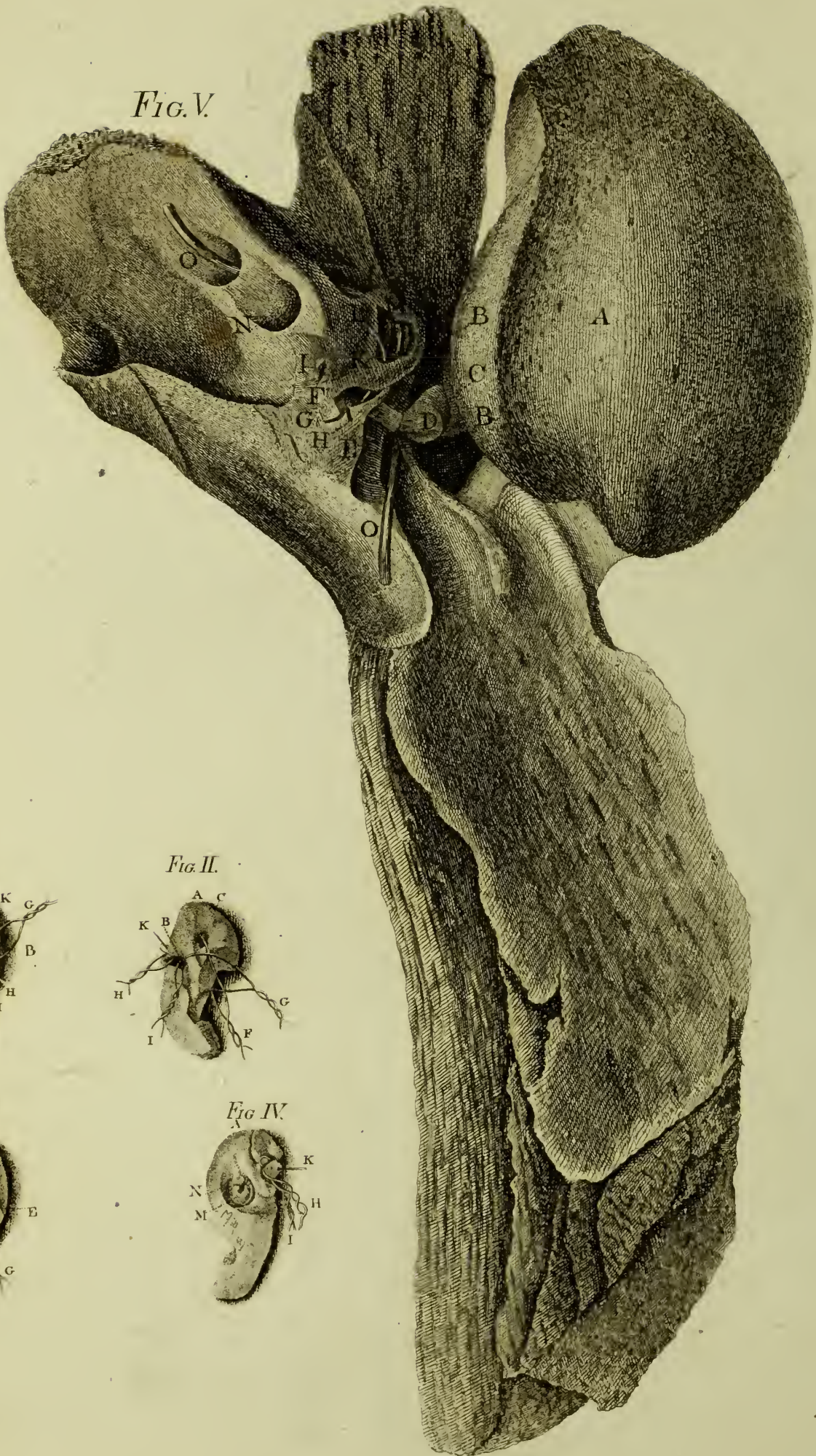


FIG. I.

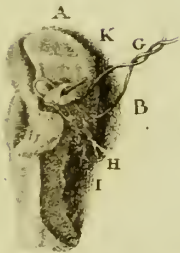


FIG. II.

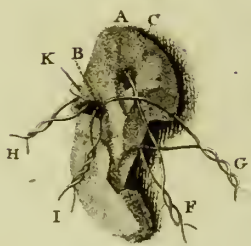
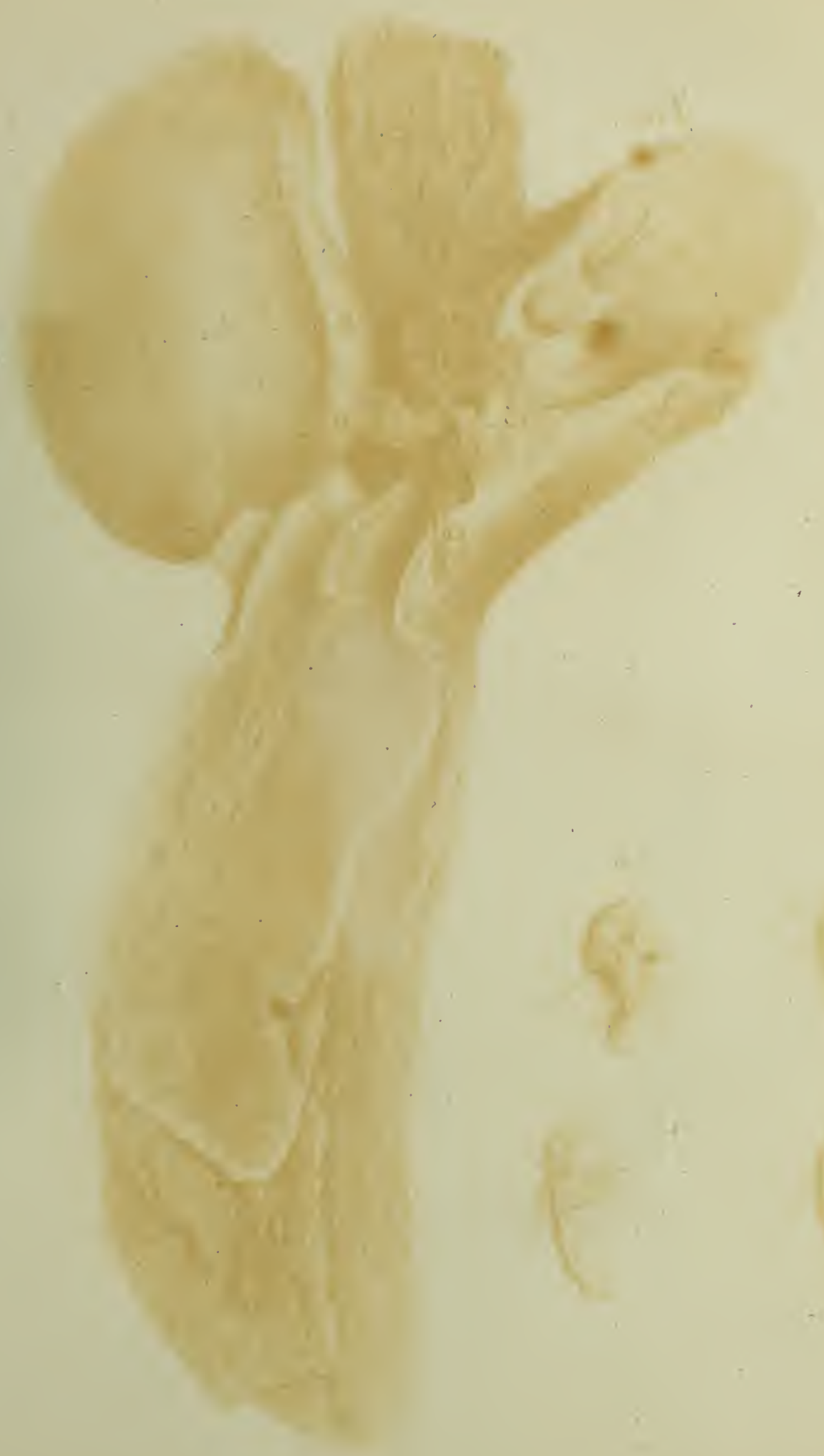


FIG. III.



FIG. IV.





H. halsb. de

ca. 1840



TAB. IV. *

- d* Shews the Continuation of the other Layer of the Lamina Spiralis lining the Scala of the Vestible.
- e* Is an Incision, where the Retina of the Scala Vestibuli begins to be continued from the Lamina Spiralis.

Explanation of Table IV. *

THIS Table represents, of its Natural Size, a Portion of the External Meatus Auditorius of the Cete Balæna, *i. e.* of LINNEUS, laid open.

- A The Outer and Wider End of the Meatus.
- B The Inner and Narrower Part of it.
- C A Smooth Spheroidal Body, the Inner End, or Root, of which, D, is Smaller than its Outer End, and is attached to the Side of the Meatus.

Explanation of Table V.

THE First, Second, Third and Fourth Figures of this Table, represent the Vestible, Semicircular Canals, and Cochlea, of the Cete Delphinus Phocæna of LINNEUS, or of the common Porpoise.

The Diameter of all the Parts, which belonged to the Right Ear, is magnified a little; nearly, in proportion to the real Diameter, as Three to Two.

The Same Parts are pointed out by the Same Letters in all the Four Figures.

- A The Outer-side of the Os Petrosum.
 - B The Vestible laid open.
 - C The Foramen Rotundum.
 - D E (Fig. 3.) The Apex and Basis of the Cochlea opened.
 - F The Ends of a Wire twisted together, after passing it, from the Foramen Rotundum, out at an Opening made into the Scala Tympani of the Cochlea.
 - G The Ends of a Wire twisted together, after passing it, from the Foramen Ovale, out at an Opening made into the Scala Vestibuli of the Cochlea.
 - H The Ends of a Wire twisted together, after passing one end of it, from a Hole in the Superior or Anterior Semicircular Canal, into the Vestible, and, from that, out at the Foramen Ovale.
 - I The Ends of a Wire twisted together, after passing both ends of it, from the Cavity of the Posterior Semicircular Canal, into the Vestible, and then out at the Foramen Ovale.
- These Two Wires are contiguous in the Canal common to the Two Perpendicular Semicircular Canals.
- K A Short Wire put into one end of the Third or Horizontal Semicircular Canal.
 - L The Hole, on the Backpart of the Os Petrosum, for the Passage of the Portio Mollis, and Portio Dura of the 7th Pair of Nerves.

M That

- M That Branch of the Portio Mollis, which furnished Nerves to the Cochlea, dried.
- N The other Branch of the Portio Mollis dried, which furnished Nerves to the Vestible and Semicircular Canals.

F I G. 5.

This Figure represents the Os Petrosum and the Parts of the Ear, of their Natural Size, in the Cete Phyfeter Macrocephalus of LINNEUS, or the Spermaceti Whale.

- A A Part of the Os Petrosum, within which there is a Large Cavity, that communicates with, or makes part of, the Cavity of the Tympanum B B. This is, in Structure and Office, analogous to the Human Mastoid Process, or to the Hollow Part of the Os Temporum of the Ape and Quadrupeds represented in Table II.
- C D E The Malleus, Incus, and Stapes, connected to each other by Ligaments. The Root of the Stapes fills the Foramen Ovale.
- F A Hole cut in the Bone, in order to shew the Cavity of the Vestible.
- G H Two of the Semicircular Canals, cut open to their Terminations in the Vestible.
- I The Scala of the Cochlea which begins at the Foramen Rotundum, which is called Scala Tympani.
- K A Probe in the Scala Vestibuli.

K k 2

L The

- L The First Gyrus of the Cochlea cut open, in which the Osseous Root of the Lamina Spiralis is observable.
- M The Second Gyrus of the Cochlea.
- N The Hole which transmitted the Portio Mollis of the 7th Pair of Nerves.
- O O A Probe in the Winding Canal, which transmitted the Portio Dura of the 7th Pair.

Explanation of Table VI.

IN this Table, some of the Principal Parts of the Ear in the Cete Delphinus Delphis are represented.

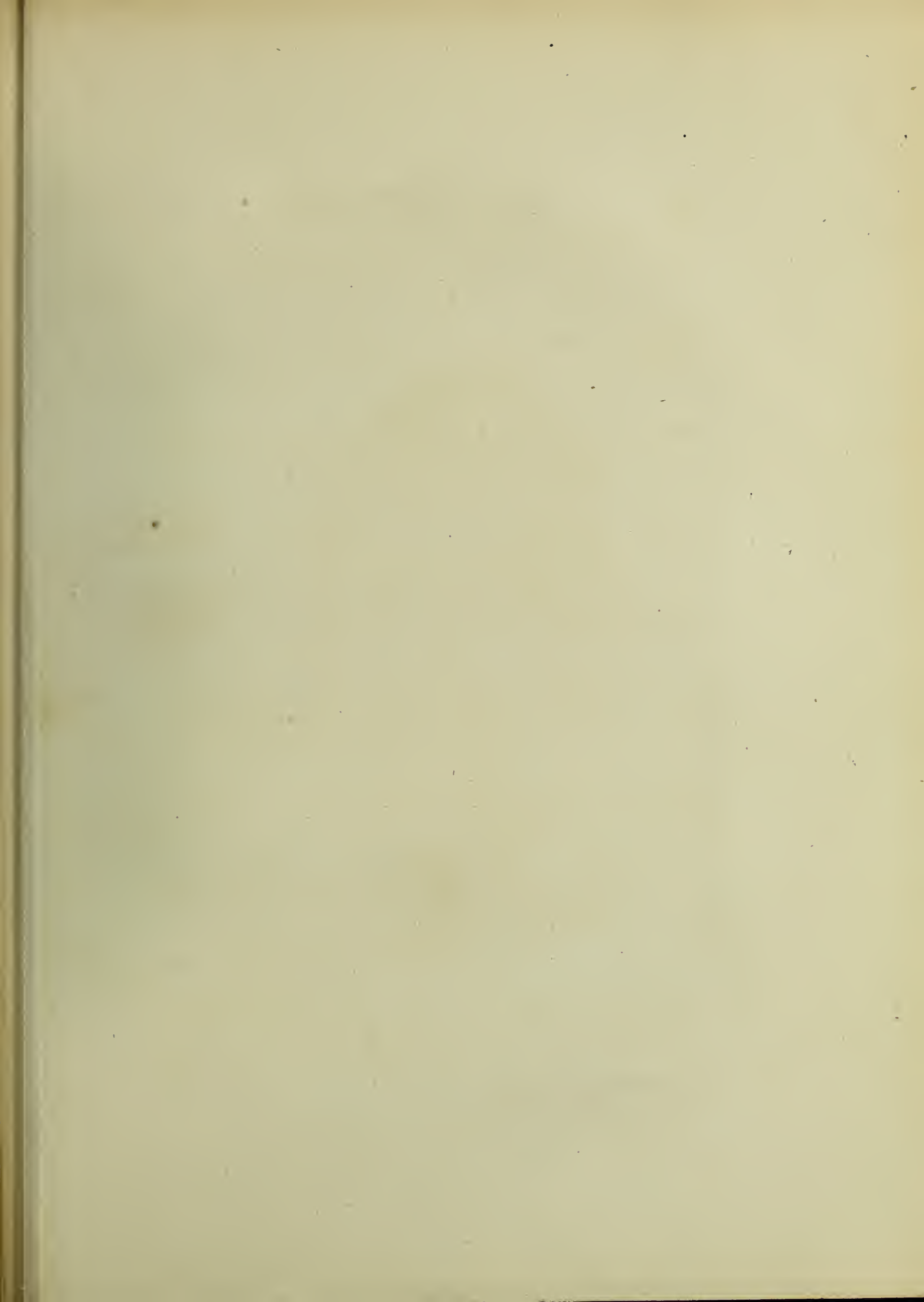
F I G. 1.

Shews the Orifice of the Meatus Auditorius Externus.

- A The Left Eye.
- B The Corner of the Mouth.
- C D White Lines or Streaks on the side of the Head and Body.
- E A Bristle introduced into the Orifice of the Meatus Auditorius Externus.

F I G. 2.

Represents the Meatus Auditorius Externus laid open, the Eustachian Tube and Cavities resembling those in the Mastoid

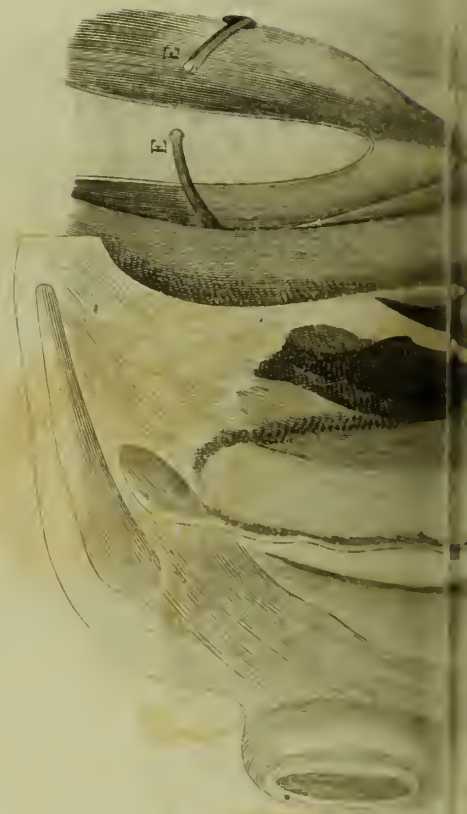


TAB. VI.

Fig. 1.



Fig. 2.



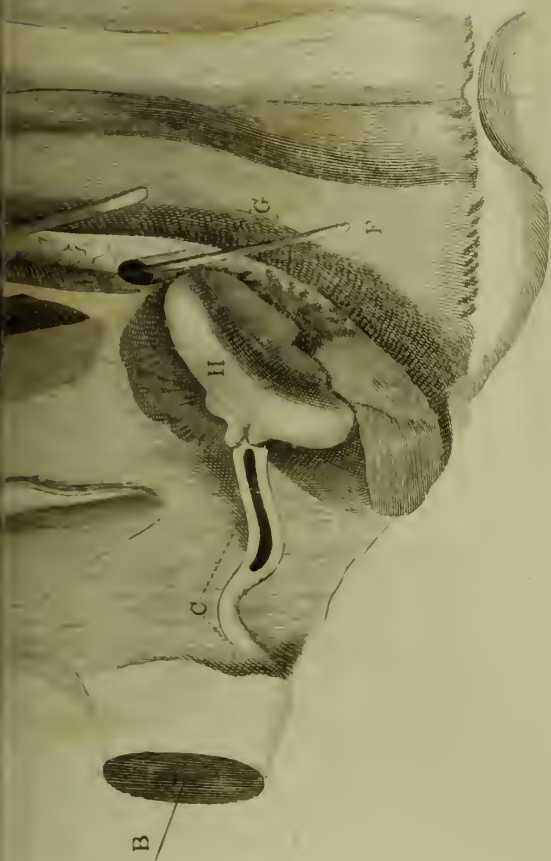
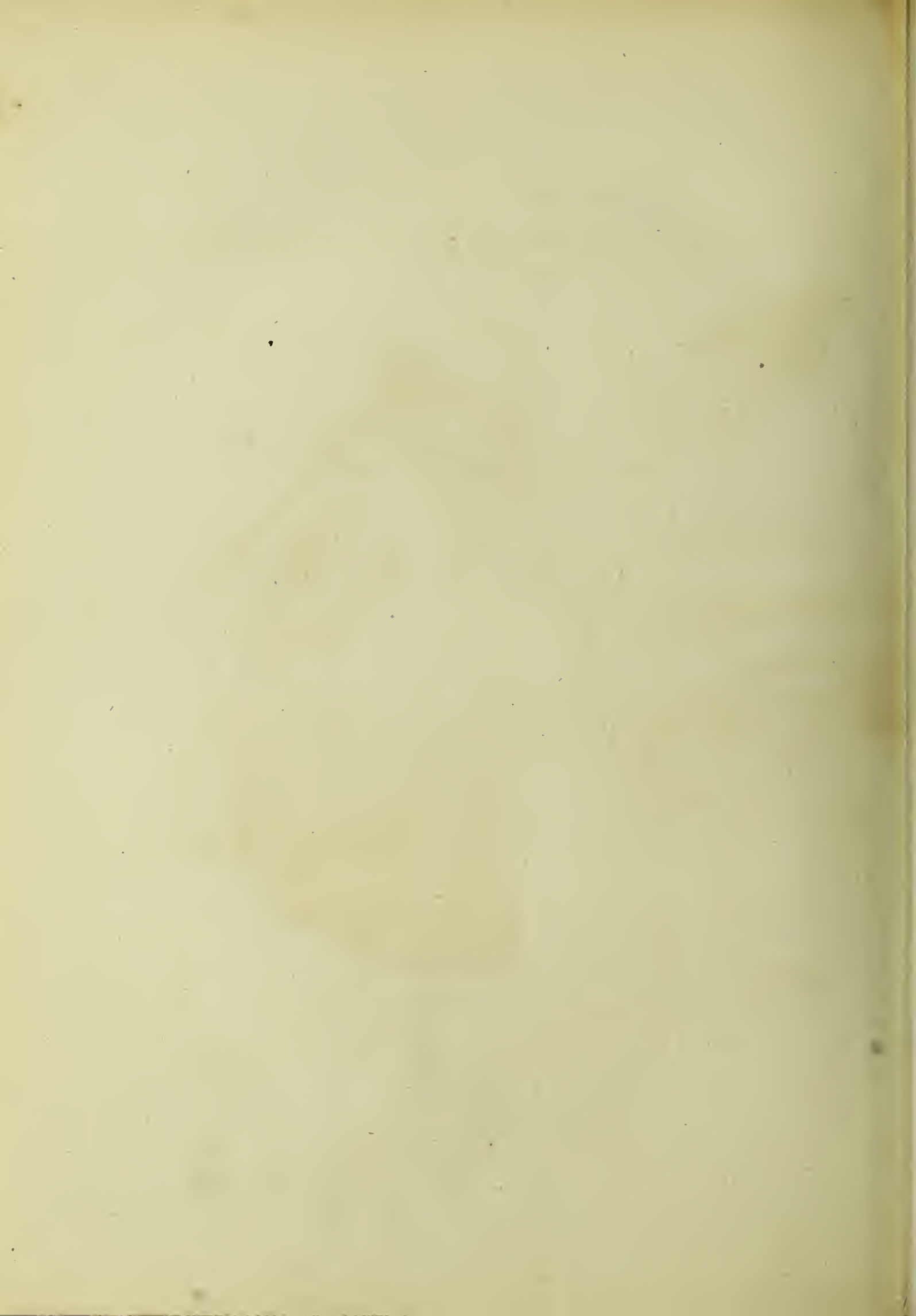


Fig. 4.



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stoid Process, with which this Tube and the Cavity of the Tympanum communicate.

- A The Eye.
- B The Orifice of the Meatus Auditorius with a Bristle introduced into it.
- C The Meatus Auditorius laid open.
- E E Probes introduced into the Eustachian Tubes.
- F G The Outer End of the Tube opening into Large Cells.
- H A Bone which is Hollow.

In F I G. 3.

- F Represents the Outer End of the Eustachian Tube, with a Probe passed from it into Large Cells.
- Another Probe passed from the Outer End of the Eustachian Tube into the Cavity of the Bone H, the Lower Part of which is cut off, in order to shew its Cavity.

F I G. 4.

Shews the Portio Mollis terminating in the Cochlea and Semicircular Canal.

- A B The Inner Sides of the Base of the Cranium.
 - C The Trunk of the Portio Mollis.
 - D The Os Petrosum.
 - E The Portio Mollis going into the Modiolus.
 - F G The Sides of the Cochlea laid open.
- H One

- H One of the Semicircular Canals laid open.
 I The Portio Dura of the 7th Pair.

Explanation of Table VII.

THE Figures in this Table represent the Situation and Connexion of the several Canals of the Ear in a Skate Fish, of their Natural Size.

F I G. I.

In this Figure, the Situation of the Two Eyes, and of Two Passages which lead from the Upper Part of the Head into the Throat, and of the several Parts of the Brain and Nerves rising from it, are represented, along with the Parts of the Ear.

AAAA Represents a Section of the Skin and other Parts of the Upper Side of the Head and Spine.

B B The Eyes.

C C Two Passages leading down into the Throat.

D The Forepart of the Cavity of the Cranium, which contains some Cellular Substance, and is filled with a transparent viscid salt Liquor.

E The Brain.

F The Cerebellum.

I I The Olfactory Nerves.

2 2 The Optic Nerves.

33 44 Nerves which resemble the 3d and 4th Pairs.

5 5 Nerves

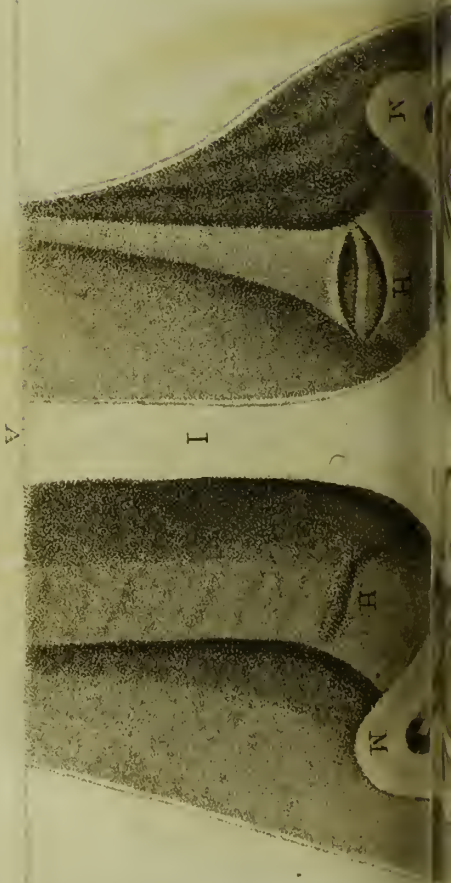


Fig III

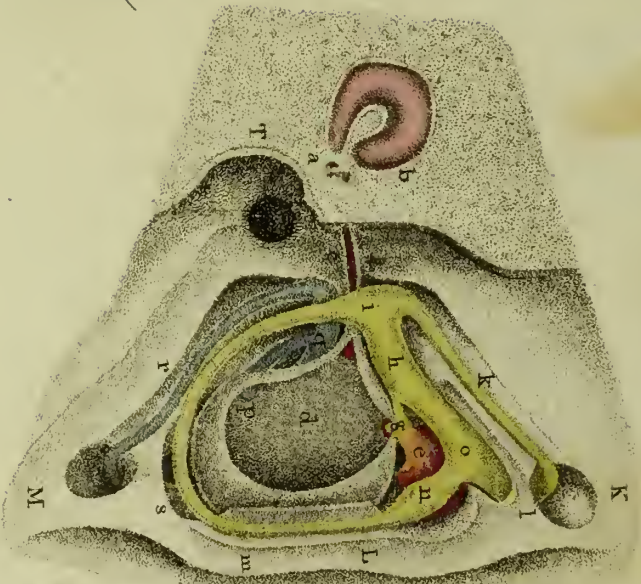


Fig II

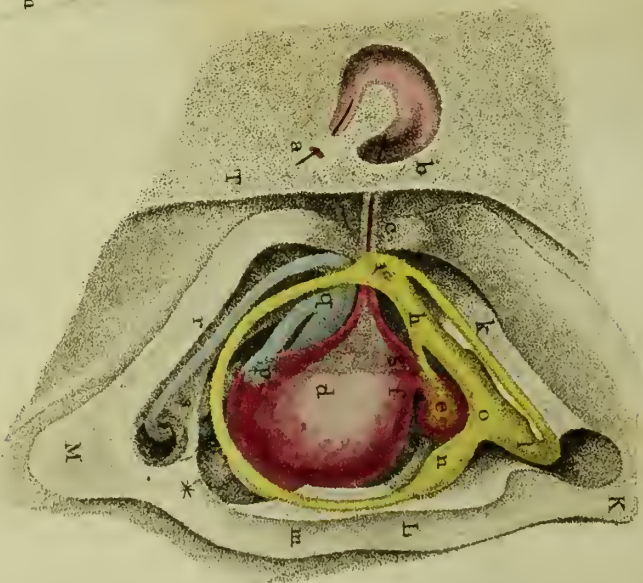
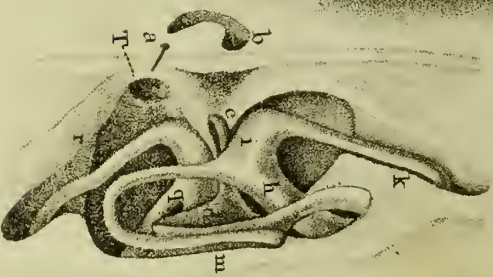


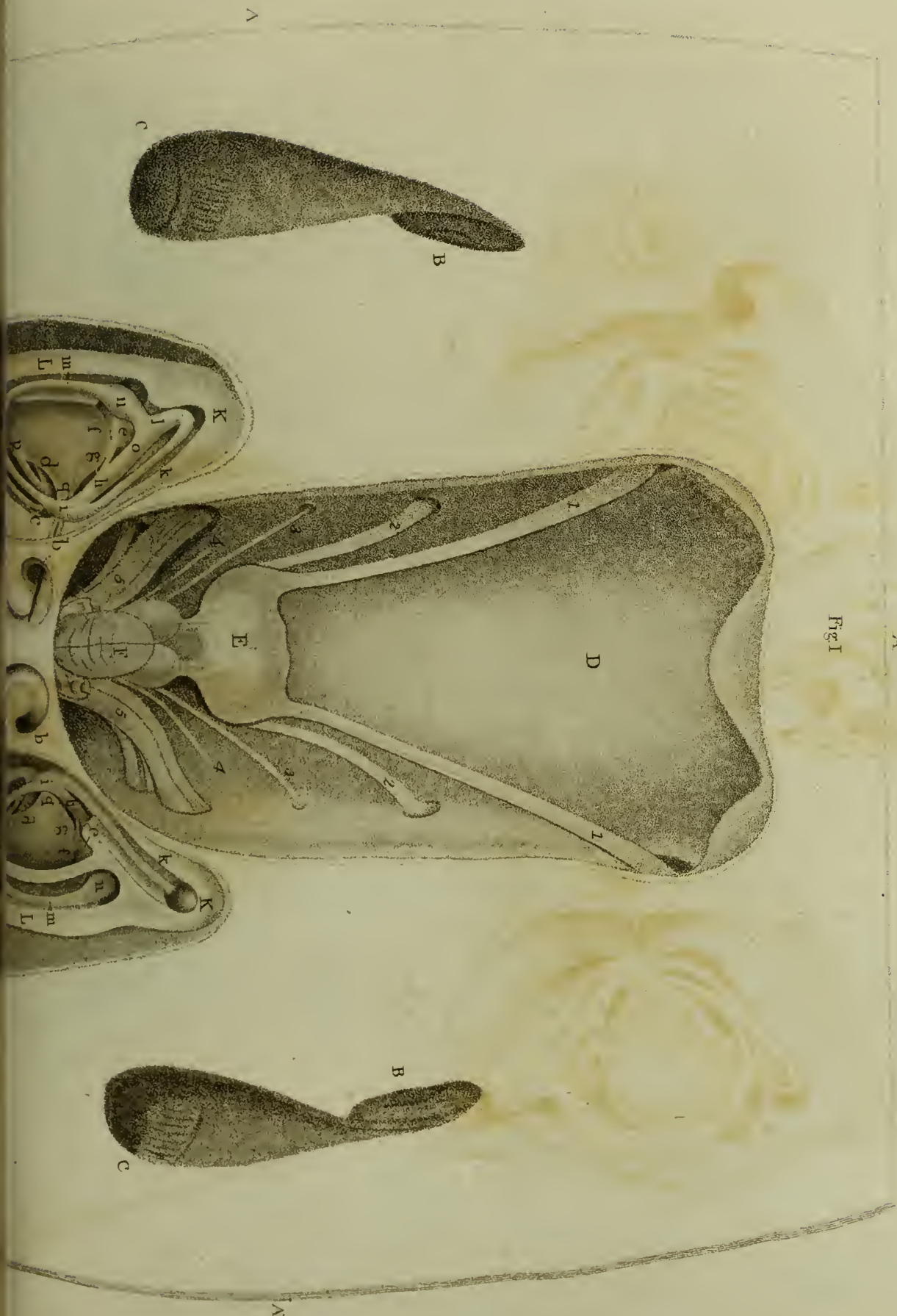
Fig IV

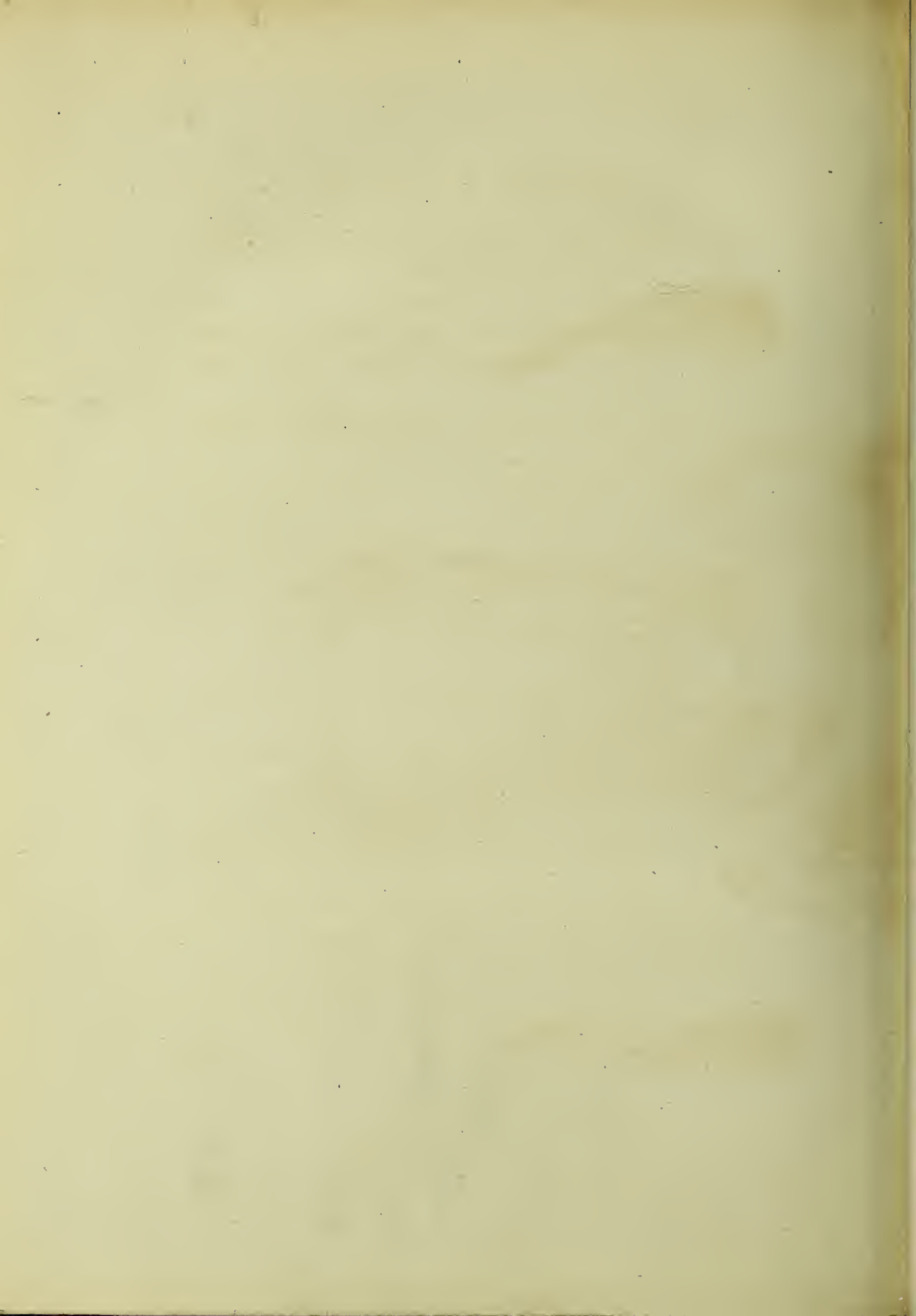


TAB. VII.

A

Fig. I





- 5 5 Nerves which resemble our 5th Pair, and likewise the *Molles* of our 7th Pair.
- G The Skin covering the Occiput.
- H H The Joints of the Head with the Spine, or Joining of the Condyles of the Occiput with the First Vertebra or Atlas.
- I The Skin covering the Spinal Processes of the Vertebrae.
- KLM KLM Thick Cartilages, cut horizontally, which cover and contain Three Semicircular, or rather Circular, Canals of the Ear, and certain Sacs, analogous to our Vestible, with which these communicate.
- a a The Mouths or Openings of the Meatus Auditorii Externi.
- ab ab Winding Canals cut open, which resemble the Conchæ of the Human Ears.
- c A Bristle passed from the Concha of the Left External Ear, into a straight Meatus Auditorius Externus, and, from it, into the Cavity of a Large Sac *d*, resembling our Vestible, which is filled, partly with a regularly-shaped white soft cretaceous Substance, and partly with a transparent viscid Fluid.
- d In the Right Ear, represents the same Sac.
- e A Small Sac, situated on the Forepart of the Large Sac *d*, containing likewise a Cretaceous Substance and Viscid Fluid.

- * A still Smaller Sac, or rather a Projection from the Backpart of the Large Sac *d*, which also contains Cretaceous Matter.
- f* The Place at which the Large Sac *d* communicates with the Small Sac *e*.
- g* A Tube leading from the Small Sac *e*, to *h*, which is a Canal common to the Anterior Perpendicular Circular Canal *i k l*, and to the Middle Horizontal Circular Canal *i m n*.
- l* Is a dilated Part or Bulb in the Anterior Circular Canal, and *n* is a similar Bulb in the Horizontal Circular Canal.
- i h o* A Large Canal common to the Anterior and Horizontal Middle Canal.
- p q* A Canal leading from the Inner and Posterior Part of the Great Sac *d*, to the Posterior Perpendicular Circular Canal *q r f*. At *f* there is a Bulb in this Canal, and at its Inferior End *q* it is Wider than it is in its Upper Part.

F I G. 2, 3, 4.

Much Larger Fishes than the former were procured for the Preparations represented by these Three Figures; and in the Preparations represented by Fig. 2, 3. the Meatus Auditorius Externus, Vestible, and the Circular Canals, were injected with

with melted Wax, tinged with three different colours, such as those with which these Figures are painted.

In the Preparation represented by Fig. 2. the Vestible was laid in view and delineated, before the injection was thrown in; and the Boundary of the Cretaceous Substance is seen at the letter *d*.

After all the Canals were injected, in the Preparation represented by Fig. 3. the Vestible was cut, and the Wax taken out of it, that its Communications with the Meatus Auditorius Externus, the Small Anterior Sac, and the Canal which leads to the Posterior Circular Canal, might be more fully seen and delineated.

The several Parts represented in these Three Figures are pointed out by the same letters as in Fig. 1. ; so that the Explanation already given of Fig. 1. beginning with the letters K L M, applies to Figures 2, 3, 4.

The Meatus Auditorius Externus *c* passes under the Termination of the Inner-part of the Middle Horizontal Circular Canal, in the Canal *i b o*, common to it and to the Anterior Circular Canal.

Behind the Meatus Auditorius Externus, the Posterior Circular Canal is contiguous to the Horizontal Circular Canal, but does not communicate directly with it by any Opening.

In Fig. 3. at the letter T, the Outer-side of a large round Hole or Aperture in the Cartilage which incloses the Vestible and Circular Canals, is delineated; and, in Fig. 4. at T,

L 1

the

the Inner-side of this Hole is represented ; and, in Fig. 2. at the same letter, the Place of the Skin is pointed out, under which this Hole is situated.

Explanation of Table VIII.

IN this Table, the Nerves of the Vestible and Circular Canals in the Right Ear of a Skate are represented, after inverting the Head, and cutting away the Cartilages which lie under them.

ABCDE A Section of the Cartilages.

F G The Right Side of the Medulla Oblongata.

H I A Nerve which, in its Distribution, resembles the Human 5th, and Portio Mollis of the 7th Pair.

K A Branch of the Portio Mollis sent to the Bulb of the Anterior Circular Canal.

L A Branch of it sent to the Bulb of the Middle Horizontal Circular Canal.

M A Branch of it sent to the Anterior Sac which communicates with the Vestible.

N A Number of Branches, forming an elegant Plexus on the under Part of the Vestible.

O Branches sent to a Small Projection or Sac at the Under and Posterior Part of the Vestible.

P A Branch

TAB. VIII.

Fig. 1.

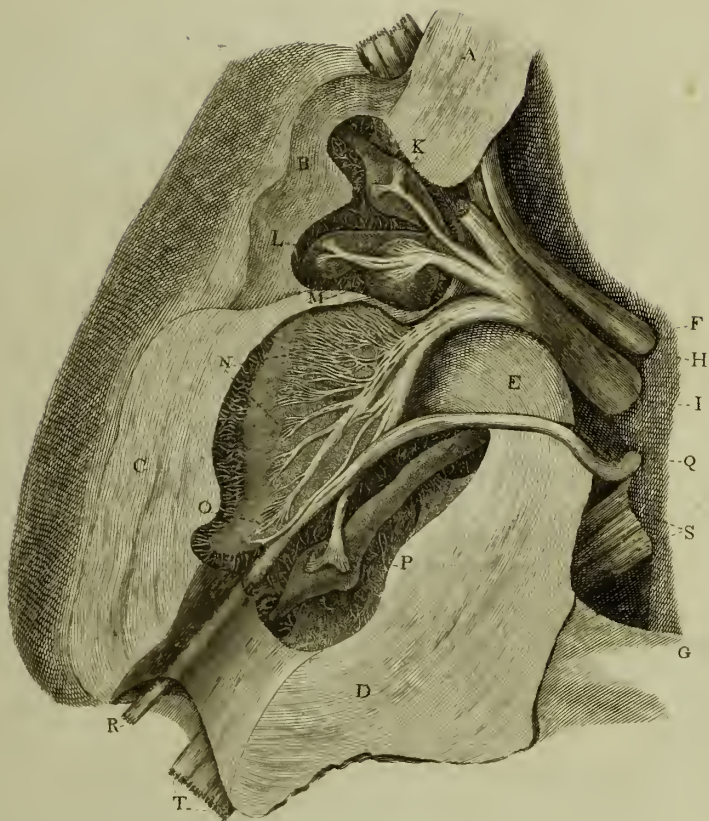


Fig. 3.

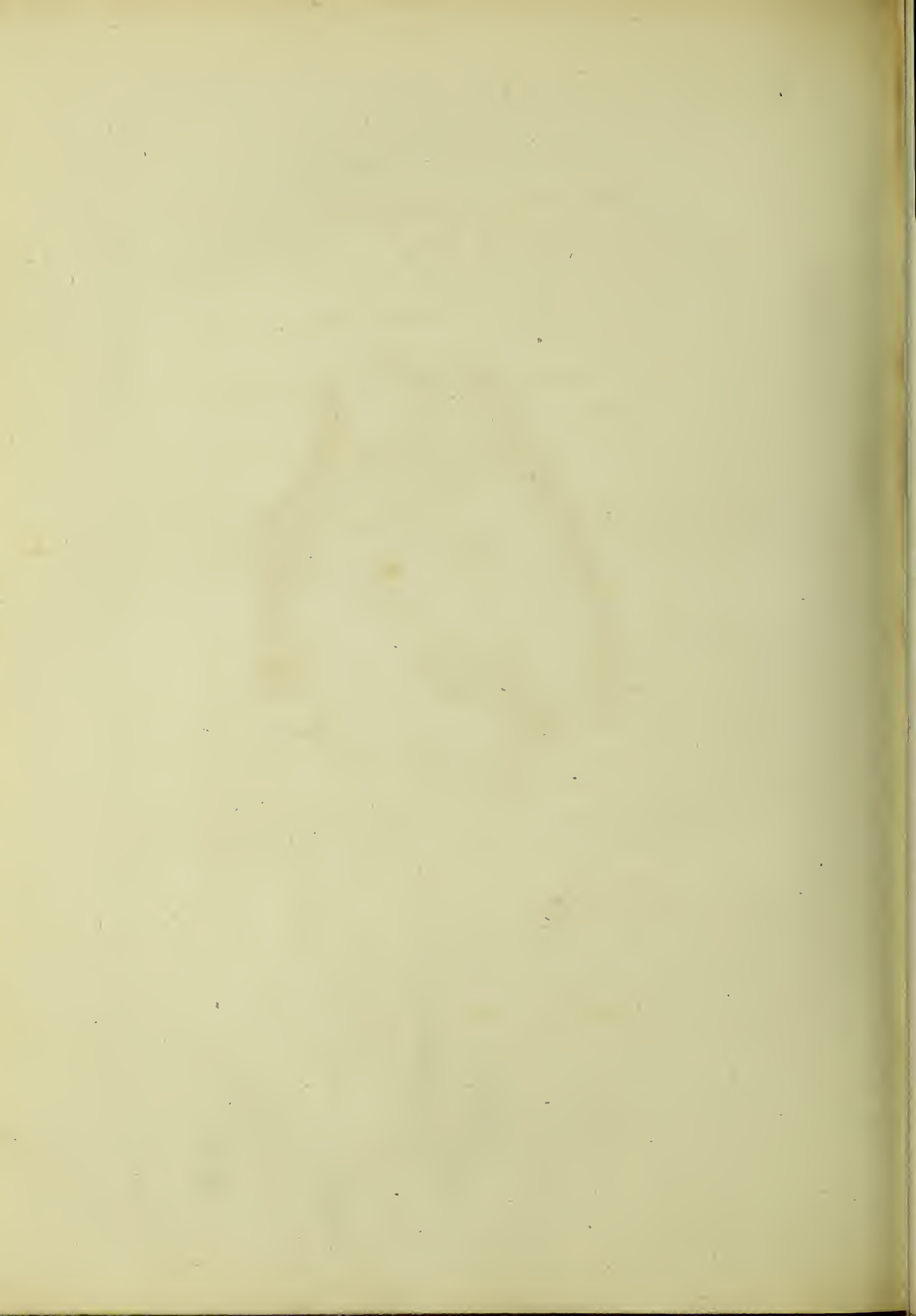


A. type delt.

Fig. 2.



W. Arthral.

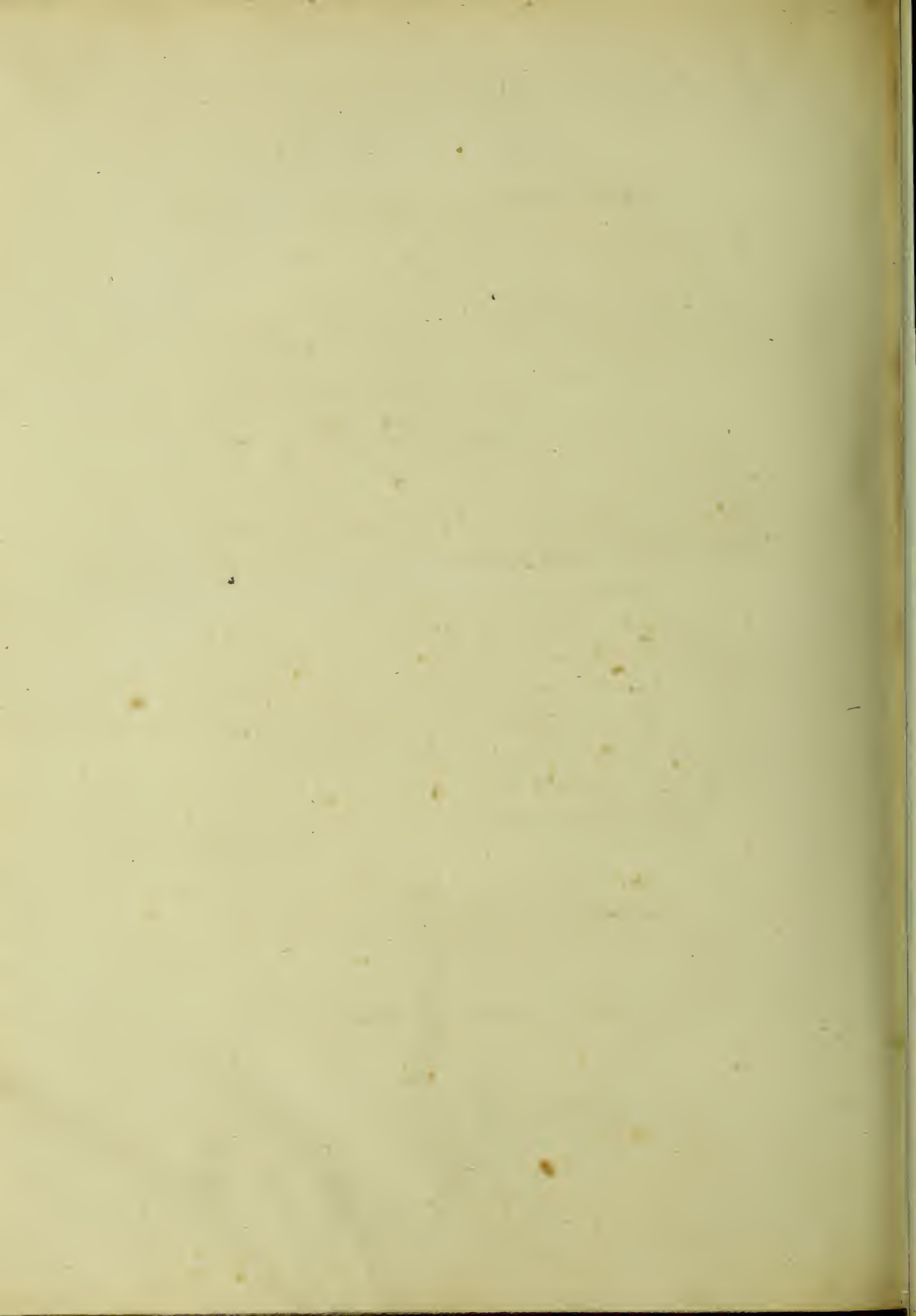


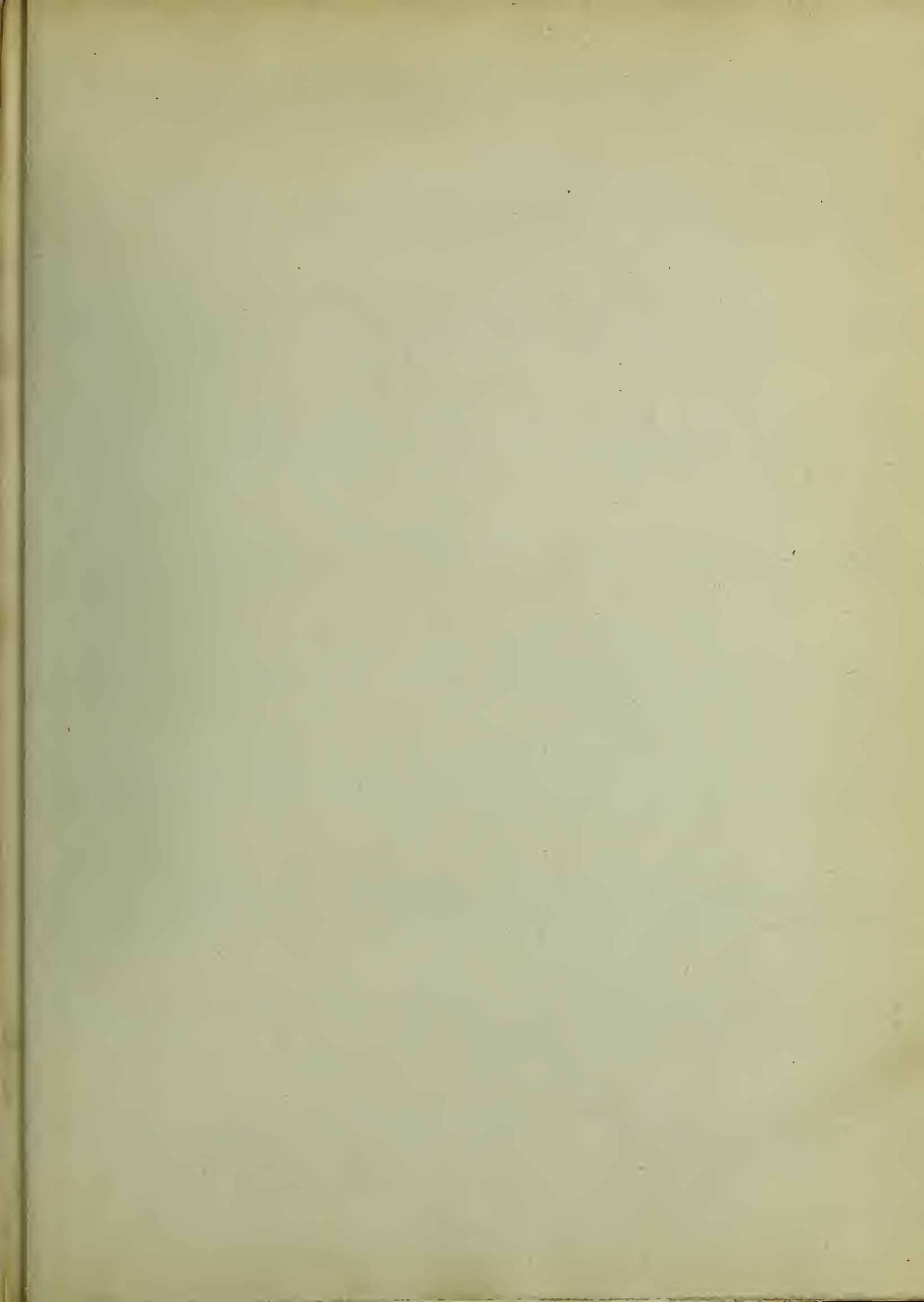
- P A Branch sent to the Bulb of the Posterior Circular Canal.
- Q A Nerve resembling the Human Portio Dura of the 7th Pair.
- S T Nerves resembling the Human 8th and 9th Pairs of Nerves.

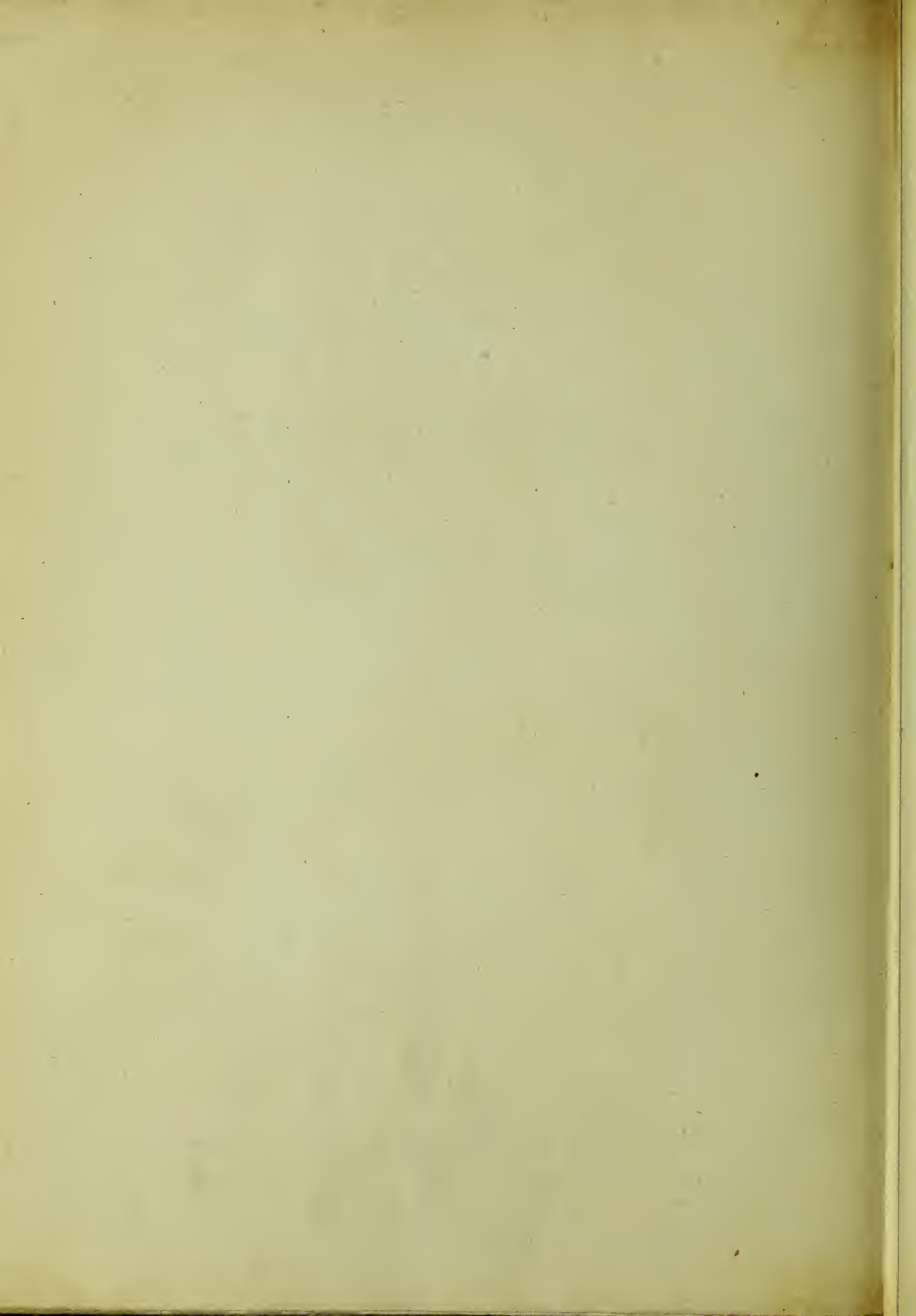
F I G. 2, 3.

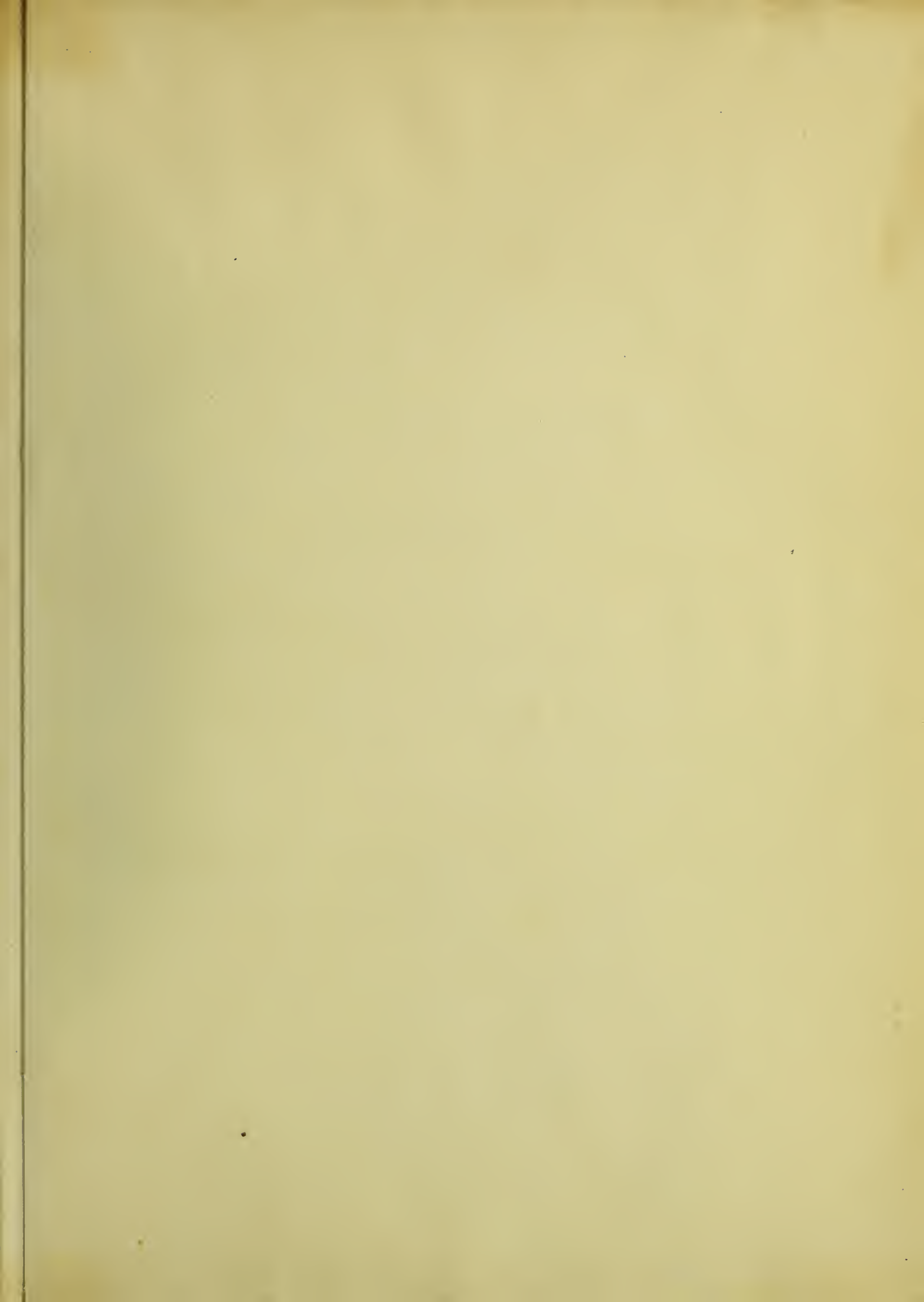
Shew, more fully, the way in which the Branches of the Portio Mollis terminate in the Bulbs of the Circular Canals.

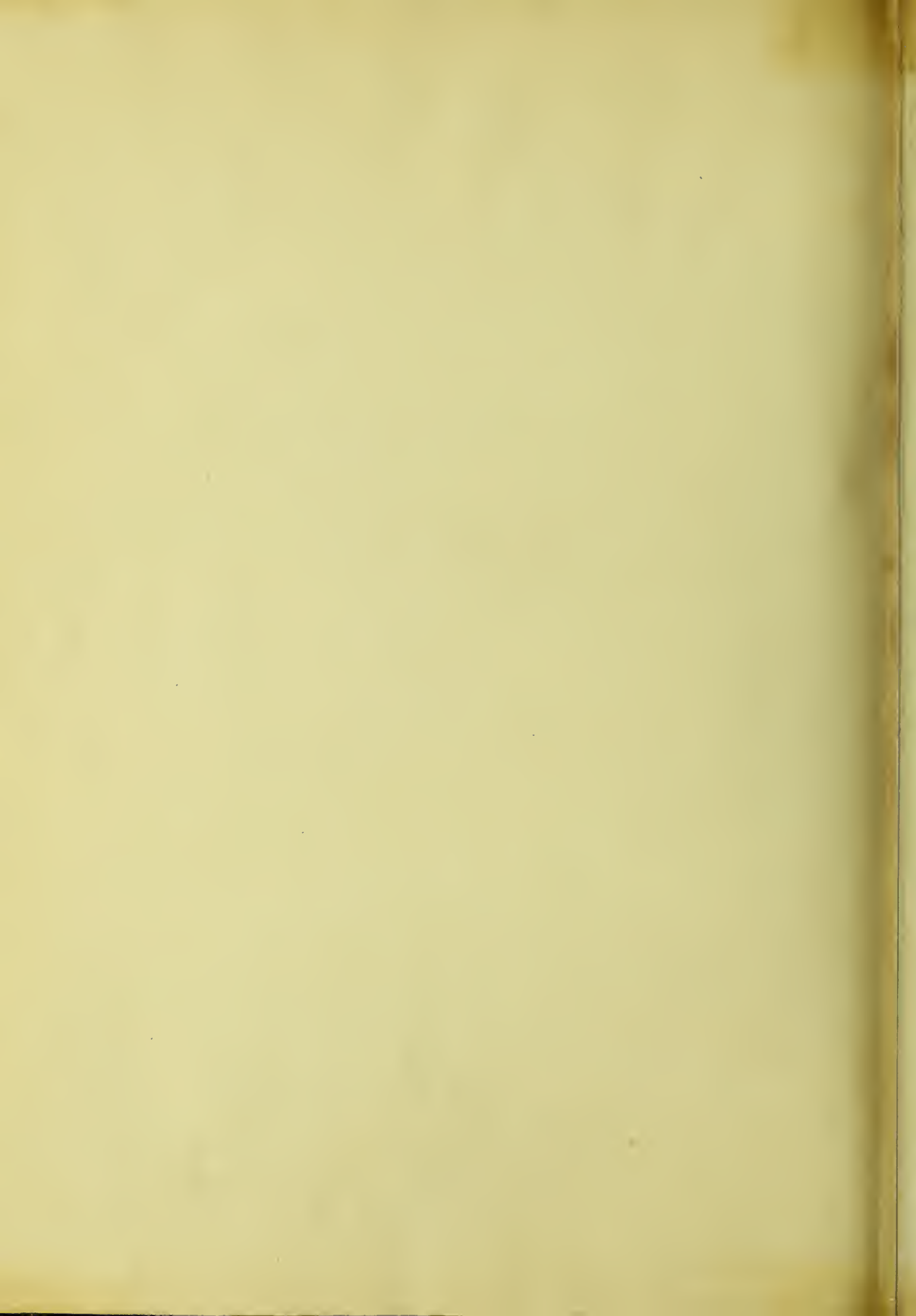
- a b* The Cylindrical Parts of the Circular Canals.
- c* (Fig. 2.) Shews the Bulb entire; and *c*, in Fig. 3., shews the Bulb cut open, in order to bring into view an imperfect Septum, *e*, on which the Nerve splits into a great number of minute Branches; which, in a very large Fish, weighing upwards of 160 pounds, I have observed to form a Plexus on the Septum; and, the Branches then becoming pellucid, it is impossible to perceive their farther Distribution on the Cylindrical Part of the Circular Canals.











Signed 14/4/81

28/2/88

